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The availability of spatial information in a situation model

Christopher Mark Hakala
University of New Hampshire, Durham

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THE AVAILABILITY OF SPATIAL INFORMATION IN A SITUATION MODEL

BY

Christopher M. Hakala

B.A., Castleton State College, 1990
M.A., University of New Hampshire, 1992

DISSERTATION

Submitted to the University of New Hampshire
in Partial Fulfillment of
the Requirements for the Degree of

Doctor of Philosophy

in

Psychology

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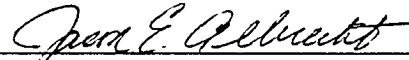
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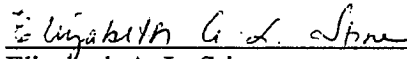
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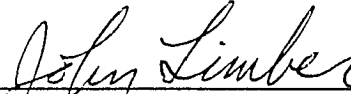
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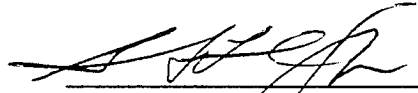
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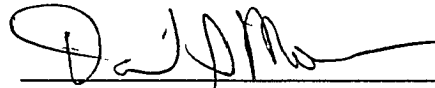
Elizabeth A. L. Stine
Assistant Professor of Psychology



John Limber
Associate Professor of Psychology



Grant L. Cioffi
Associate Professor of Education



Daniel G. Morrow
Research Associate Professor of
Psychology

August 2, 1995
Date

DEDICATION

This dissertation is dedicated to Tammy, our baby, and
my parents for always being there for me.

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This dissertation has been greatly improved through the guidance and support of Ed O'Brien. During the process of writing this document, Ed has been patient, whether it be reading another draft, or calming me down when I would panic. Ed has taught me what it is to be a researcher and I appreciate all the time he has spent with me. I could not have completed this dissertation without his assistance.

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ABSTRACT

THE AVAILABILITY OF SPATIAL INFORMATION
IN A SITUATION MODEL

by

Christopher M. Hakala
University of New Hampshire, September, 1995

Four experiments were conducted to determine the availability of spatial information from a situation model. In Experiment 1, participants were told to either focus on spatial information while reading the texts or to read for comprehension. At the end of each text, participants were presented with a probe word to name. The probe word was either spatially associated or dissociated with the final spatial location of the main character. Participants named the spatial probe more quickly only when told to focus on spatial information. Experiment 2 used reading time as a dependent measure to determine ease of integration of spatially associated or dissociated information. Again, participants were told either to focus on spatial information or to read for comprehension. Participants noticed a violation of coherence between the critical sentence and previously presented spatial information only when told to focus on spatial information. Experiments 3 and 4 replicated Experiments 1 and 2 respectively, with re-written passages designed to implicitly encourage the readers to focus on spatial information. In Experiment 3 participants named spatial probe more quickly only when told to focus on spatial information. However, in Experiment 4, participants noticed a violation of coherence regardless of explicit experimental instructions. Results are discussed within the Construction-Integration model (Kintsch, 1988).

SECTION I: INTRODUCTION

A primary goal of models of discourse comprehension is to describe the processes by which readers develop a coherent memory representation from text. The resulting memory representation is typically assumed to consist of at least two levels: a representation of the text itself (e.g., a text base) containing information that is explicitly stated in the text; and a representation of the situation described by the text (e.g., a mental or situation model). Early work on text comprehension focused almost exclusively on describing the development of the text-base (e.g., Fletcher, 1981; Kintsch, 1974; Kintsch & van Dijk, 1978; Kintsch, Kozminksky, McKoon, Streby & Keenan, 1975; Kintsch & Vipond, 1979; Ratcliff & McKoon, 1978). However, readers not only have access to explicitly presented text information from memory; they can also draw on information from general world knowledge to develop a more enriched representation of the situation described by the text. Consequently, recent research has focused increasingly on how readers use text-base information as well as general world knowledge to develop the mental (or situation) model (e.g., Albrecht, 1993; Albrecht & O'Brien, 1993; Bower & Morrow, 1990; Garnham, 1981; Glenberg & Langston, 1992; Glenberg & Mathews, 1993; Glenberg, Meyer & Lindem, 1987; Graesser, Singer & Trabasso, 1994; Huitema, Dopkins, Klin & Myers, 1993; Johnson-Laird, 1983; Keenan, 1992; Kintsch, 1988; Miller & Kintsch, 1985; Morrow, 1985a; Morrow, 1985b; Morrow, Bower & Greenspan, 1989; Morrow, Greenspan & Bower, 1987; Morrow, Bower & Greenspan, 1990; O'Brien, 1995;

O'Brien & Albrecht, 1992; Rips, 1986; Singer, Graesser & Trabasso, 1994; van Dijk & Kintsch, 1983).

For example, taking the perspective of the main character while reading has been described as influencing the availability of information from general world knowledge (e.g., Albrecht, O'Brien, Myers & Mason, 1995; Anderson & Pichert, 1978; Anderson, Pichert & Shirey, 1983; Baillet & Keenan, 1986; Black, Turner & Bower, 1978; Bloom, 1988; Borland & Flammer, 1985; Bower & Morrow, 1990; Fass & Schumacher, 1981; Flammer & Tabuer, 1983; Grabe, 1979; McDaniel, 1984; O'Brien & Albrecht, 1992; de Vega, 1995). When reading from a given perspective, participants presumably have access to discourse-relevant information as well as world knowledge that is consistent with the adopted perspective. Thus, the resulting situation model should contain not only the explicit text-base information (i.e., the text base) but also information from general world knowledge that is consistent with the protagonist's perspective (e.g. Anderson & Pichert, 1978).

A related issue is the degree to which readers encode and utilize spatial information while reading. In narratives, it is often particularly important to pay attention to where the main character is located in the narrative world. In addition, it may also be important to know about specific spatial relations between the main character and other characters and objects within the narrative world. Presumably, if readers focus on the location of the main character, they should also update the situational model to incorporate the addition of new spatial information (e.g., Garrod & Sanford, 1990). Thus, information such as the name of the room that the main character is in should become more accessible when the protagonist has moved to that room (e.g., Rinck & Bower,

1995). In addition, information relevant to the spatial location of the main character may also be more accessible to the reader. For example, if a story described the main character as entering a coffee shop, information relevant to a coffee shop may also become more accessible to the reader as the situation model is updated.

Much of the evidence supporting the idea that readers focus on spatial information, however, has been found with experiments using methodology requiring participants to memorize maps or spatial layouts (e.g., Bower & Morrow, 1990; Denis & Zimmer, 1992; Gray Wilson, Rinck, McNamara, Bower, & Morrow, 1993). Evidence using narratives without the aid of pre-memorized maps has been mixed. For example, O'Brien and Albrecht (1992) (see also, de Vega, 1995) presented evidence that readers are aware of the spatial location of the main character. However, neither O'Brien and Albrecht (1992) nor de Vega (1995) find evidence that readers are also concerned with the spatial location of objects with respect to the location of the main character (e.g., O'Brien & Albrecht, 1992; Zwaan, 1993; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994).

Additionally, much of the previous research has only tested for the availability of previously presented spatial information. If spatial information is incorporated into the situation model, it should also provide the reader with access to contextually related, but unstated information.

Thus, the goal of the current dissertation is to examine the role that spatial information plays in discourse processing. Specifically, I am interested in understanding the conditions under which both explicitly stated spatial information and contextually relevant, unstated spatial information becomes available to the reader. Before describing the experiments, however, a review of the literature on text comprehension is presented to

provide the reader with background into some of the major theoretical ideas that have led to the development of the current dissertation.

SECTION II: TEXT-BASE MODELS

Any model of text comprehension must be designed to account for a wide variety of data and theory (e.g., how readers encode and represent information in memory; how readers overcome processing limitations; how a coherent memory representation is constructed from text; how readers monitor coherence of both information currently active in memory as well as contextually relevant information no longer active in memory). In this section, I describe the research that has addressed these issues and the logic behind the text processing framework for an early model of discourse comprehension.

Evidence for the Propositional Representation of Meaning in Memory

One of the most basic issues for any model of text comprehension is to explain how readers represent information obtained from reading. Kintsch (1974) has argued that information is not represented literally in memory; rather, information appears to be represented in terms of propositions. A proposition can be defined as an abstract representation of meaning. To better understand the propositional representation, consider the following example from Kintsch (1974).

Turbulence forms at the edge of a wing and grows in strength over its surface, contributing to the lift of a supersonic aircraft.

According to Kintsch (1974), readers would parse such a text into propositions, and then organize the resulting propositions in memory. For example, the above text can be described by the following propositional text-base:

- P1. (FORM, TURBULENCE)
- P2. (LOC: AT, 1, EDGE)
- P3. (PART OF, WING, EDGE)

- P4. (GROW, TURBULENCE, STRENGTH)
- P5. (LOC: OVER, 4, SURFACE)
- P6. (PART OF, WING, SURFACE)
- P7. (CONTRIBUTE, TURBULENCE, LIFT, AIRCRAFT)
- P8. (SUPERSONIC, AIRCRAFT)

Each proposition contains one abstract idea unit from the original text (see Turner & Greene, 1978, for a more complete description of deriving a text base). A typical proposition consists of a predicate and one or more arguments. Consider the example presented above; the first proposition contained a verb and an argument (FORM¹ and TURBULENCE). Through such a process, all information explicitly presented in the original text is maintained in memory.

Substantial evidence has been presented to support the psychological reality of the propositional text-base representation (e.g. Fletcher, 1986; Kintsch, 1974; Kintsch, et al, 1974; Kintsch & Keenan, 1973; Kintsch & van Dijk, 1978; Kintsch & Vipond, 1979; McKoon, 1977; Ratcliff & McKoon, 1978). For example, Ratcliff and McKoon (1978) presented participants with one of three types of sentences. For example,

1. The colonel sucked a lollipop.
2. The pauper chopped wood and lugged water.
3. Geese crossed the horizon as the wind shuffled the clouds.

The above sentences differed in word length as well as in the number of propositions required to describe the text-base. Ratcliff and McKoon (1978) had participants read the texts and then presented them with a list of probe words. The task was to verify whether or not the word had been previously presented text. If text is organized linearly, position of words within the text should influence degree of priming; words that are closer to each other in the surface structure of the text should prime each other. However, if text is organized according to propositional structure, degree of priming should vary in terms of

the underlying propositional structure. For example, the above sentences can be parsed into the following propositional text bases.

P1. (SUCK, COLONEL, LOLLIPOP)

P2. (CHOPPED, PAUPER, WOOD)

(AND, P1, P3)

(LUG, PAUPER, WATER)

P3. (CROSS, GEESE, HORIZON)

(AS, P1, P3)

(SHUFFLE, WIND, CLOUDS)

Ratcliff and McKoon found stronger priming within propositions than between propositions, even when the actual surface information were closer together in the text (i.e., WIND primed CLOUDS more than it primed HORIZON).

Thus, there appears to be substantial evidence that information obtained from reading is stored in memory in terms of propositions rather than directly as words. However, a structural description of the text base represents only one criteria necessary for the development of an adequate model of text comprehension; models of comprehension also require a description of how information is processed, organized, and stored in long-term memory. In the next section, I describe an early process model presented by Kintsch and van Dijk (1978) and provide evidence for and against this model.

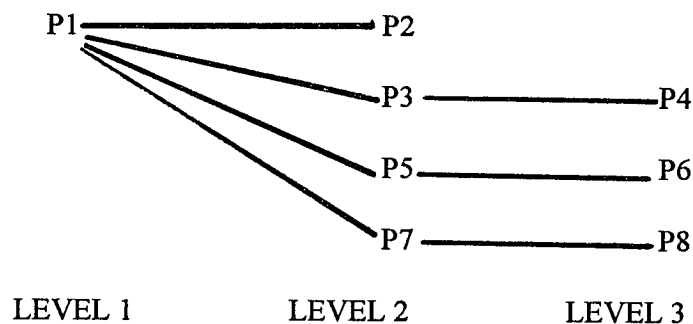
The Kintsch and van Dijk Model

Models of text comprehension differ in the way they account for the ability of individuals to process the large amount of information encountered while reading. One of the most influential models of text comprehension was developed by Kintsch and van Dijk (1978) (see also, Kintsch & Vipond, 1979). The model was designed to describe both the processes used by readers to comprehend text as well as the resulting memory

representation. Kintsch and van Dijk's (1978) model was comprehensive and addressed a number of issues that had not previously been discussed. Specifically, the model described how readers deal with limited capacity processing resources; how coherence was maintained; and how readers stored information in long-term memory.

To account for processing limitations, Kintsch and van Dijk (1978) argued that text is processed across a series of cycles. During each cycle, a number of propositions are input into memory and organized. Propositions are then connected if they share arguments in common with each other. Kintsch and van Dijk refer to this as argument overlap. If two propositions share argument overlap, they are considered to be cohesive. If a text-base has at least one path leading from every proposition to another, it is considered to be coherent (Kintsch & Vipond, 1979).

For ease of comprehension, consider the text presented earlier, which was drawn from Kintsch (1974). Propositions two (LOC: AT, 1, EDGE) and three (PART OF, WING, EDGE) would be cohesive because they share an argument, namely, the concept EDGE. Further, if the information is presented in the form of a coherence graph² (Kintsch & Vipond, 1979) we also see that the text is connected; there is a path that connects all the propositions.



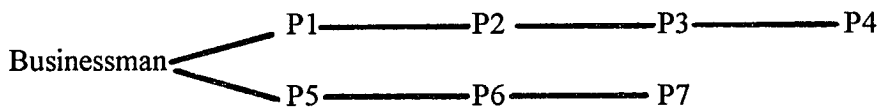
According to Kintsch and van Dijk, the representation can be described as taking the form of a hierarchically organized, interconnected set of propositions. Important information is stored at a higher level in the hierarchy than less important information. The proposition that is highest in the hierarchy is referred to as the superordinate proposition (e.g. Kintsch & Vipond, 1979). The superordinate proposition has the highest probability of being recalled, as it has the highest probability of being maintained across input cycles (McKoon, 1977).

Because of limited capacity memory constraints, readers process texts across a series of cycles. To ensure the highest probability of maintaining coherence across processing cycles, a reader must rely on a buffering strategy to maintain a subset of information from previous processing cycles active in memory. The maintained propositions are selected to facilitate the integration of propositions entering on subsequent cycles, and are maintained in a short-term memory buffer (or in active memory). To ensure that the appropriate propositions are selected, readers rely on a strategy Kintsch and van Dijk (1978) referred to as Leading-Edge, in which the most important (as determined by height in the hierarchy) and recent propositions are selected to be maintained in active memory. The remaining propositions are then dropped from the input buffer. The number of propositions entering on each cycle, as well as the number of propositions selected to remain active in the short-term memory buffer, are free parameters of the model. The capacity of the reader may vary as a function of overall level of arousal, processing strategy that the reader may bring to the situation, or age (Kintsch & Vipond, 1979; Spilich, 1985).

McKoon and Ratcliff (1980a) have also argued that position in the representational hierarchy, rather than distance between information in the text surface structure predicts ease of accessing information from memory. To support this notion, McKoon and Ratcliff (1980a) had participants read passages such as the following:

- P1. The business man gestured to a waiter.
- P2. The waiter brought coffee.
- P3. The coffee stained the napkins.
- P4. The napkins protected the tablecloth.
- P5. The business man flourished documents.
- P6. The documents explained a contract.
- P7. The contract satisfied the client.

The propositional structure would be represented as follows



Two themes were presented in each passage, and each formed a cohesive, but separate series of propositions. The text base consisted of two parallel set of linked nodes, each beginning at the concept BUSINESSMAN. McKoon and Ratcliff (1980a) demonstrated that priming was stronger for concepts that were closer together in the hierarchical propositional structure than those that were further away from each other (for example, P1 primed P5 more than P2 primed P6). If surface structure controlled accessibility from memory, information that was closer together in the actual text should have primed each other. However, propositional structure was a better predictor, supporting the notion of a hierarchical structure as described by Kintsch and van Dijk (1978).

Further evidence supporting the leading-edge strategy was presented by Fletcher (1981) who examined the contents of the short-term memory buffer. According to Kintsch

and van Dijk (1978), readers select information on the basis of recency and importance to be held over in the short-term memory buffer. To test this, Fletcher (1981) presented participants with passages and probed for recall at various points during the experimental session. Information predicted to be held over in the short-term memory buffer was recalled better than information that would not be predicted to be held over. Further, Fletcher (1981) demonstrated that information that had been encoded during the same processing cycle, but that had not been held over in the buffer was recalled as poorly as propositions from previous cycles. Fletcher (1981) then replicated the same general result with on-line response to probe words, providing compelling evidence that the leading-edge strategy accurately described the contents of information held over for further processing (e.g., Kintsch & van Dijk, 1978).

The leading-edge strategy was initially designed to minimize the likelihood that readers would encounter a proposition that has no immediate connection available in short-term memory. However, sometimes text is poorly written or an author may want to purposely leave information vague as a means of engaging active processing strategies by the reader. Kintsch and van Dijk's model provides three possible strategies for dealing with a break in the overall coherence of the text. The preferred strategy is for the reader to perform a reinstatement search of long-term memory. If information is located in memory that would allow for comprehension to continue, the propositions are reactivated and integrated into the current representation. At this point, the text is again coherent, the reinstated propositions become part of the representation, information is again selected to remain in the buffer and the next cycle begins.

A second strategy to resolve a coherence break is to construct a bridging inference (e.g. Haviland & Clark, 1974). That is, a reader could access information from general world knowledge and use that information to connect the incoherent portions of text. Again, the reactivated information now becomes part of the representation in memory and is subject to the same processes as explicitly stated text information. In fact, according to text-base models, the only conditions under which general world knowledge will be incorporated into the representation is when it is required to resolve a coherence break. A "last-resort" strategy that a reader can engage in is to allow the coherence break to remain. This will result in an incomplete memory representation as well as poor comprehension.

The processes described thus far are referred to as microprocesses (Kintsch & Vipond, 1979; Kintsch & van Dijk, 1978). Kintsch and Vipond (1979) argued that these microprocesses operated in short-term memory and lead to the development of the text-base representation. Further, they argue that at the same time the microprocesses are constructing a representation of the text base in short-term memory, a second set of processes, called macroprocessors, are operating. Macroprocesses lead to the development of an overall representation of the meaning or the gist of the text (i.e., a first attempt at describing the situation or mental model). Unfortunately, however, neither Kintsch and van Dijk (1978) nor Kintsch and Vipond (1979) describe this aspect of their model in great detail. One of the few papers that addresses this issue was by Vipond (1980) who claimed that macroprocessors operate on very similar principals as microprocessors (see also, Kintsch, 1986; van Dijk, 1980); however, the unit of information that is manipulated differs. According to Vipond (1980), microprocessors

operate at the level of the proposition and the sentence, and macroprocessors operate at the level of the paragraph. Further, he claimed that the levels differ in the information that is important. For example, macroprocessors are important in tasks requiring integration, long-term retention and retrieval of text information while microprocessors might be more important in question answering and recognition tasks and in tasks that require locating information in text (see also, Graesser, et al., 1994). Although the conclusions drawn from this paper are tenable, the theory put forth by Vipond is never completely outlined with respect to the processes that a reader would use to manipulate macro information. However, the idea of local (micro) and global (macro) processes have recently come to the front of research on reading comprehension and will be taken up again in the discussion of situation models.

A number of criticisms of Kintsch and van Dijk's (1978) original model have been suggested. For example, a main tenant of Kintsch's model was that coherence was maintained by argument overlap. However, Keenan, Baillet and Brown (1984) pointed out that while argument overlap may be sufficient for coherence, it is not necessary. Consider the two sentences below:

Fido is in the yard.
Fido is in the house.

Despite that fact that sentence 1 and sentence 2 share an argument (i.e., FIDO), these sentences could not be considered coherent.

Garrod and Sanford (1982) have also demonstrated that argument overlap is not a necessary component of coherence. Consider the following sentences:

- 1a. Mary put the clothes on the baby.
- 1b. Mary dressed the baby.
2. The clothes were made of pink wool.

According to Kintsch and van Dijk, sentences 1a and 2 should be coherent because they share the argument, CLOTHES. Alternatively, sentences 1b and 2 should not be coherent because there is not argument overlap. To resolve the incoherence, a bridging inference would have to be drawn; however, such elaborative processing takes time, and would thus should lead to an increase in reading times on the second sentence. However, Garrod and Sanford (1982) found no difference in reading time between the two conditions, suggesting that argument overlap was not necessary for coherence to occur.

A second criticism of Kintsch and van Dijk's (1978) model is that it does not account for the development of a representation that captures the situation described by the text. Although Kintsch and Vipond (1979), Kintsch and van Dijk (1978) and Vipond (1980) describe macroprocessors as generating a representation of the gist of the text, it could be argued that these issues were not described sufficiently to explain how readers develop a multi-level representation of text in memory. In addition, Garnham (1981) states that a situation model will include information from general world knowledge that is relevant to the current situation. Text-base models only allow for the influence of general world knowledge to resolve coherence breaks.

A third criticism of the Kinstch and van Dijk model was that it failed to take into account alternative ways that information could be connected in memory. For example, Keenan et al. (1984) argued that causal connections also play a role in the development of the memory representation (see also, Black & Bern, 1981; Duffy, Shinjo & Myers, 1987; Myers, 1990; Myers, Shinjo & Duffy, 1990). To account for such findings, Trabasso and Sperry (1985) and Trabasso and van den Broek (1985) described a representational

system that consisted of a causal chain of events in memory. According to Trabasso and his colleagues, the representation of a text takes the form of a causal chain that connects earlier portions of a text to later portions via causal links. The major goal of the representational system was to predict the rated importance of any given statement.

According to Trabasso and Sperry (1985), both the number of connections and whether or not an event was on the causal chain were both good predictors of rated importance. The results of several experiments suggest that causal analysis is a simple, yet effective way to demonstrate the importance of information within a text (e.g., Fletcher & Bloom, 1988; Fletcher, Hummel & Marsolek, 1990; O'Brien & Myers, 1987).

Additional evidence to support the importance of causal relations was provided by a re-analysis of the results of O'Brien (1987) by O'Brien and Myers (1987). O'Brien (1987) had participants respond to probe words that either were or were not reinstated by the final sentence of a passage. In the re-analysis, O'Brien and Myers (1987) found that number of causal relations were the best predictor of reinstatement time, suggesting that an understanding of the causal relations between elements of a discourse are an important component of the structure of the underlying memory representation.

However, a problem with much of this research is that the assumptions about causal processing were made in the absence of a process model that accurately predicted how such a representation was constructed. Fletcher (1986) found that a strategy based on plans and goals of the reader best described how such a representation would be developed. That is, readers often focus on and more strongly encode (i.e., integrate) information that is pertinent to the plans and goals of the reading situation (e.g., Garrod & Sanford, 1990; Seifert, 1990). This suggests that any comprehension process model must

focus on plans or goals (i.e., causal relations) to describe how a reader would develop an accurate memory representation. According to this strategy, a reader would attempt to satisfy plans or goals by attempting to connect causal antecedents with causal consequences during comprehension.

Fletcher and Bloom (1988) further developed this process model and incorporated the causal structure assumptions of Trabasso and his colleagues (e.g., Trabasso & Sperry, 1985; Trabasso & van den Broek, 1985) along with many of the processing assumptions of the Kintsch and van Dijk (1978) model. They referred to their model as the current-state selection strategy. To test this model, Fletcher and Bloom (1988) had participants read passages that were designed to lead to the development of a strong causal chain from the opening sentence to the final sentence of the story. They found that a comprehension model based on the buffering of the most recent causal antecedent without a causal consequence accounted for the most variance in reading time in the multiple regression model. Fletcher and Bloom claimed that while participants read, they attempted to develop a representation of a causal chain in memory. The current-state selection strategy allowed the reader to develop a causal chain that linked the opening statement to the final goal outcome of a text while it minimized the number of times long-term memory had to be searched to access a causal antecedent. When a causal consequence was located, the antecedent and consequence were added to the long term memory for the causal representation and a search for the next antecedent and consequence was initiated.

A number of experiments have provided support for Fletcher and Bloom's (1988) model. For example, Bloom, Fletcher, van den Broek, Reitz and Shapiro (1990) presented participants with narratives that contained an underlying causal chain. As predicted by the

current-state selection strategy, causal links that co-occurred in short-term memory increased reading times. Presumably, the increase in reading time was due to participants focusing on and connecting the causal antecedent with the causal consequence and transferring the subsequent representation to long-term memory. Second, they found that potential causal relations that do not co-occur in short-term memory have no impact on reading time. Thus, if participants had not maintained the last causal antecedent for a causal consequence, the information was not connected in memory or added to the causal chain. Third, they found that participants attempted to connect causal antecedents at the sentence boundary, as reinstatement searches increased reading times. Thus, although the causal consequence did not increase reading time if it did not co-occur in short-term memory with its causal antecedent, it did increase reading time at the conclusion of the sentence, as the participant attempted to re-establish causal coherence and integrate that information into the developing memory representation.

Additionally, Fletcher et al., (1990) found that if a participants were presented with a sentence that included only causal antecedents, continuation sentences that were related to it were read more quickly, as participants attempted to locate the causal consequence. Further, when the causal antecedent did not yet have a causal consequence, target words drawn from this sentence were recognized more quickly, providing strong evidence that the causal antecedent was being maintained in a highly active state. Last, continuation sentences generated by the subjects were more likely to contain causal consequences when there was a causal antecedent without a consequence. Taken together, these findings represent strong evidence that readers are driven to develop a causal representation of

text, and that the current-state selection strategy is a reasonable strategy to predict how this process could occur.

However, Rizzella and O'Brien (1995) presented evidence that failed to provide complete support for the current-state selection strategy. Rizzella and O'Brien (1995) presented participants with passages containing two potential causal antecedents for an ambiguous causal consequence. For example, consider the following passage:

Jimmy was playing baseball with his friend. Jimmy's friend pitched the ball to him. The ball hit Jimmy in the arm. Jimmy could not believe how much the pitch hurt. His arm muscles began to feel very sore. Jimmy knew it would hurt for days. His arm even began to turn red and swell. Because of this, Jimmy stopped playing and said he was going home. Jimmy hopped on his bike and sped down the street. Unfortunately, he turned too sharply and fell off his bike. When he arrived home, his mother asked him why he was bruised.

Both ball and bike were potential causal antecedents for the causal consequence, "When he arrived home, his mother asked him why he was bruised." This sentence was designed to reinstate a search for a causal antecedent. Because there were two potential candidates, the critical test is to determine which is reinstated more quickly. According to Fletcher and Bloom (1988), the most recent causal antecedent without a causal consequence should be reactivated more quickly, as it has not yet become part of the causal chain. Rizzella and O'Brien (1995) demonstrated that the most recent causal antecedent was named more quickly when there was no elaboration on either causal antecedent, supporting the current-state selection strategy. However, when the early causal antecedent was elaborated, as was the case in the example presented above, there were no differences in time to name the causal antecedents, suggesting that importance, as well as recency, determines

availability of causal antecedent. Thus, according to Rizzella and O'Brien, the current state selection strategy is incomplete; the most recent causal antecedent without a causal consequence will be maintained, but importance also influences what is available to the reader. If a causal antecedent is elaborated, it will be much easier for the antecedent to quickly become reactivated.

Research on causal analysis provides an additional example of how readers may develop a text-base representation. Again, however, a model based on causal connections focuses on the development of a representation of text itself rather (including necessary inferences) than a representation of the situation described by the text. In the section that follows, I describe research on situation models to describe how readers develop a representation of what a text is about rather than just a representation of the information that has been explicitly stated in the text.

SECTION III: MENTAL/SITUATION MODELS

The research described above describes the development of a memory representation of the text itself. Information that is explicitly stated in the text is preserved and organized according to a theoretical structure (e.g., a hierarchical text base according to Kintsch and van Dijk, 1978 and a causal text base structure according to Fletcher and Bloom, 1988). However, these models are incomplete; that is, they fail to describe the nature of the representation of the situation described by the text. In this section, I describe the research on situation models.

Presumably, as described earlier, a mental or situation model is developed simultaneously with the text base and is a representation of what the text is about, or the situation described by the text (e.g., Garnham, 1981). It is generally assumed that readers draw on pragmatic information, linguistic information, general world knowledge, in combination with information explicitly stated in the text to develop a more enriched representation of situation described by the text (Garnham, 1981).

An early study suggesting that readers construct a representation above and beyond a simple text-base was performed by Bransford, Barclay and Franks (1972). In their experiment, participants read sentences such as the following:

- 1a. Three turtles rested on a floating log, and a fish swam beneath them.
- 1b. Three turtles rested on a floating log, and a fish swam beneath it.
- 2a. Three turtles rested beside a floating log, and a fish swam beneath them.

2b. Three turtles rested beside a floating log, and a fish swam beneath it.

After reading several such sentences, participants were presented with a sentence verification task. Predictions made according to text-base models would suggest that participants should be equally likely to confuse 1a with 1b as they would 2a and 2b. However, Bransford et al. (1972) found that participants were more likely to confuse sentences 1a and 1b than 2a or 2b, suggesting that they formed a representation of the situation described by the text that was independent of the representation of the text base. Specifically, the representation must have contained information concerning the location of the turtles. If the turtles are sitting on the log, and the fish swim beneath the log, the fish also swim beneath the turtles. However, in sentences 2a and 2b, the turtles are next to the logs. Presumably, the fish could swim beneath the logs without swimming beneath the turtles. A text base representation fails to describe how such a subtle difference would be incorporated into the memory representation.

One of the more influential perspectives on mental/situation models was presented by Johnson-Laird (1983). According to Johnson-Laird (1983), a reader develops a mental representation that allows an understanding of all the relations between words in a sentence. For example, for participants to fully comprehend this sentence, "John threw the ball to Sue," they must understand all the relations between the words that make up the sentence. According to Johnson-Laird, the mental model can be represented in an image-like form, and includes not only information presented in the text, but also information from general world knowledge. Thus, the representation constructed of this situation would include text information (such as the propositions derived from the sentence) as well as general world knowledge (such as how balls are usually thrown) combined into a

single, image-like representation. Although the model is tenable, it merely describes one possible structure of a mental model. However, the general idea of a different level of representation in addition to the text base is still important and has formed the basis for many of the theories that followed (e.g., Kintsch, 1988; Kintsch, 1992).

An issue related to the development of a situation model is readers' ability to maintain coherence at both a local and global level. That is, text must be coherent with both the current contents of active memory as well as with information that came much earlier in the text and general world knowledge. For example, Graesser et al. (1994) have argued that the development of a situation model implies that readers are active constructionists while processing text. That is, readers are active problem solvers, often attempting to ensure that information is both locally and globally coherent.

McKoon and Ratcliff (1992), however, have argued that readers are not routinely concerned with maintaining global coherence. They claim that readers strive to maintain local coherence, but only maintain global coherence when information from the text requires that it be made (i.e., when there is a local coherence break) or when the information necessary for drawing a global inference is readily available. McKoon and Ratcliff (1992) refer to their model as the Minimalist Position. To support this position, McKoon and Ratcliff (1992) presented participants with passages containing embedded goals. If readers were concerned with global coherence as well as local coherence, they should notice a violation of a goal at either a local or a global level. However, McKoon and Ratcliff (1992) found no evidence that readers were routinely concerned with monitoring global coherence.

Glenberg and Mathews (1992) have argued that there need not be the distinction between minimalism and situation model approaches. According to Glenberg and Mathews, minimalism deals with automatically generated inferences, while situation models are not necessarily constructed automatically. Further, Garnham (1992) argued that minimalism is just a reconceptualization of an older theory (i.e., Kintsch & van Dijk, 1978), and that it fails to take into account the constructionist nature of both local and global coherence. That is, to develop an adequate representation of a text (i.e., a text-base as well as a situation model), it is often necessary to use both processes.

To examine whether or not readers maintain both local and global coherence while developing a situation model, Albrecht and O'Brien (1993) examined reading time for critical sentences that violated global coherence. Specifically, participants were presented with passages that began with an elaborate description of a dispositional characteristic of a protagonist. For example, a passage might describe a protagonist, such as Mary, as being a vegetarian who refused to eat meat. After several filler sentences designed to background the protagonist's characteristics, participants were presented with a critical sentence that was either consistent, inconsistent or neutral with respect to the elaboration presented earlier (e.g., Mary ordered a cheeseburger and fries). Despite the fact that the critical sentence was always locally coherent (according to Kintsch & van Dijk's (1978) model), they found that reading time increased on the critical sentences following an inconsistent elaboration.

Hakala and O'Brien (1995) extended this result by using the same passages as Albrecht and O'Brien (1993). However, they varied whether local or global coherence was violated to determine the impact that each type of violation would have on memory.

Similar to O'Brien and Albrecht (1992), Hakala and O'Brien (1995) found that when a critical sentence violated either local or global coherence, reading time for the critical sentences increased. Further, memory for the information increased when global coherence was violated (replicating Albrecht & O'Brien, 1993). The more enriched situation model allowed for greater memory of the globally incoherent texts because the reader was able to use information from general world knowledge to draw inferences which allowed integration of inconsistent information. When local coherence was violated, however, both portions of inconsistent information were available in active memory. Thus, readers typically deleted or edited information to make it consistent with previously presented information (cf. Black et al., 1979) and allowed for comprehension to continue.

Thus, it appears that while processing narrative text, readers develop a multi-level representation that contains not only explicitly mentioned information, but also information that is contextually relevant and that aids in the construction of the situation model. As stated at the outset of this dissertation, I am interested in determining the role that spatial information plays in the development of the situation model. However, before a discussion of the research on spatial information is presented, a process model is discussed that describes how readers are able to construct a multiple level representation.

Construction-Integration Model

Kintsch (1988; Kintsch, 1992) describes a model of discourse comprehension that attempts to explain how readers develop a situation model. According to the Construction-Integration model, readers develop a multi-layered memory representations from a text: a linguistic level, including the words and phrases presented in the text; a conceptual level of the information explicitly stated in the text (i.e., the text-base); and a

situation model. The manner in which much of the processing occurs is similar to the earlier model presented by Kintsch and van Dijk (1978). For example, according to Kintsch (1988), text is processed across a series of cycles, with a subset of information being retained to facilitate integration across cycles. In addition, the probability of information being recalled is a function of number of times the information is held over in the memory buffer (e.g., the strength of the encoding of the information).

However, the Construction-Integration model provides a number of benefits over previous models of text processing. Specifically, according to Kintsch (1988), information from general world knowledge is also part of the developing representation. He describes comprehension as occurring in two stages: construction of the representation and then integration of the representation.

The first stage, construction, involves parsing text, inputting the resulting propositions, and activating related propositions from general world knowledge. Information that is explicitly stated in the text primes and reactivates information that it is related to in general world knowledge through a spreading activation process. As a reader is processing text, information that is explicitly stated in the text will be represented along with the related information from general world knowledge. According to the model, information receives different degrees of activation as a function of whether or not it had been explicitly stated in the text. The resulting representation is much more enriched than the text-base, but it may be incoherent or even inconsistent (Kintsch, 1988) because of the "dumb" activation of unnecessary propositions from general world knowledge that may be related to the concepts, but that do not fit within the current context.

During the integration phase, activation settles on information that is relevant to the context of the story and the goals that the reader brings to the text. If the reader has specific goals and focuses on information to achieve those goals, that information is likely to receive higher levels of activation. This, in turn, will increase the likelihood that information will be carried over across input cycles (e.g., Garrod & Sanford, 1990). The information that has the highest level of activation is most likely carried over in the buffer to the next processing cycle. If the integration stage is successful, activation levels settle on the relevant propositions (both on propositions that were explicitly stated and information from general world knowledge can be highly active) and comprehension continues. When the integration process fails (i.e., inconsistent information is encountered) problem solving strategies may be required for comprehension to continue. The resulting representation is a propositionally based description of the situation described by the text.

Thus, through such a model, readers are able to develop a situation model by combining the information that is explicitly stated in the text with related information from general world knowledge. The construction phase activates related propositions (either previously presented in the text or general world knowledge) and the integration phase excludes unwanted propositions and allows for a coherent situation model to emerge. If information is inconsistent with the situation model, it is detected during the integration phase and problem solving strategies are used to resolve the inconsistency. Information that has received more activation is more available to the reader as a result of being carried over across a number of processing cycles.

In the next section, I describe the work on spatial information. Immediately following this section, I present four experiments designed to examine issues that emerge from the review.

SECTION IV: FOCUS ON SPATIAL INFORMATION

During the past several years, researchers have become increasingly interested in examining the role that spatial information plays in the development of the situation model. Specifically, researchers have examined whether or not readers focus on and integrate spatial information during the on-line processing of narrative texts (e.g., Albrecht & O'Brien, 1992; Bower & Morrow, 1990; de Vega, 1995; Denis & Zimmer, 1992; Gray Wilson, et al., 1993; Haenggi, Kintsch, & Gernsbacher, 1995; Rinck & Bower, 1995; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994). Presumably, if readers focus on this information, according to the Construction-Integration model, this information should receive higher levels of activation and be more likely to be available to the reader. However, the issue of spatial information is complex. Research on this topic has typically addressed one of two interrelated issues: readers' ability to develop a detailed spatial representation, including the location of objects relative to a main character; and, readers' awareness of the spatial location of the main character. Determining which point of view more accurately describes the reading process allows for predictions to be made concerning exactly what may or may not become reactivated during the on-line processing of text. Further, it may also be important in determining the degree to which spatial detail is integrated into the situation model.

Evidence that Readers can Form Detailed Spatial Models

According to Bryant (1992), individuals can develop an accurate spatial memory by combining information from both world experience and the presented spatial

information (see also, Rinck & Bower, 1995). Further, Bryant (1992) argued that the resulting memory representation is identical regardless of the form the original information is in (e.g., a map or a text). Theoretically, then, a person who walks through an environment or studies a map of a spatial layout will develop the same representation of the spatial environment as a person who simply reads a detailed description of that environment.

There is evidence to partially support Bryant's argument. For example, Denis and Zimmer (1992) found that participants were able to develop accurate spatial maps from written descriptions, as evidenced by map drawings after learning the descriptions. Subjects maps were structurally similar to the corresponding spatial configurations, often maintaining some of the metric properties of the original map. However, participants who studied maps were somewhat better at maintaining metric properties inherent in the maps than participants who read descriptions. In addition, participants in these experiments were aware of the researchers interest in their ability to remember spatial information. Further, results from several experiments demonstrated that although response times to spatial questions were comparable between the two conditions, accuracy varied as a function of how participants learned the spatial layouts. In fact, Denis and Zimmer (1992) warned that although they have demonstrated that readers were able to construct spatial representations from reading, their results did not conclusively demonstrate whether or not readers actually constructed spatial representations that were identical to representations derived from maps.

Although Bryant's proposal has merit, there is evidence that readers are not always able to develop an accurate spatial representation (e.g., Ehrlich & Johnson-Laird, 1982;

Mani & Johnson-Laird, 1982; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994; Zwaan, 1993). For example, Mani and Johnson-Laird had participants read texts that described the location of various objects in relation to each other. The texts either provided a description of only one possible layout (determinate) or it provided a description that could be captured with more than one layout (indeterminate). For example, consider the following description:

A is behind D.
A is to the left of B.
C is to the right of B.

In this description, there is only one possible way for the objects to be organized. This was contrasted with the following type of description:

A is behind D.
A is to the left of B.
C is to the right of A.

This description can give rise to two possible layouts, and is considered indeterminate.

Mani and Johnson-Laird demonstrated that participants were able to develop a spatial representation only when the description of the text was determinate (e.g., unambiguous).

When the description was indeterminate, readers only remembered a verbatim representation of the text.

Additionally, in a study designed to determine how well readers monitor information surrounding the location of the main character, Franklin and Tversky (1990) had participants imagine themselves as characters with various objects located in their environment. Franklin and Tversky (1990) found that participants were sensitive to imagined spatial locations around the body, suggesting that they could use cues to develop a mental representation of the location of objects surrounding the main character.

Specifically, when probed, participants were faster to respond to objects that were imagined to be in front of or behind rather than to objects that were imagined to be on the left or the right hand side. Additionally, Bryant, Tversky and Franklin (1992) demonstrated that when an internal location was specified (that is, participants were told to actually think of themselves in place of the main character), participants were better at locating objects that were in front of them rather than behind them. Further, in the externally located perspective (that is, a third person, observer position), participants were equally fast to respond to probes in front and behind them, suggesting that participants have the ability to use the information from the perspective provided to them to make judgments that are consistent with the way things are actually organized in the world.

Evidence that Readers are Aware of the Spatial Details of the Text

Although the evidence that individuals are capable of developing a spatial model from both studying maps as well as text is compelling, there is conflicting evidence concerning whether or not readers focus on spatial details of a text during the on-line processing of narratives. In addition, the question of the degree to which readers focus on spatial details is not clear: do readers simply focus on the spatial location of the main character, or do they focus on all spatial details, including the location of objects with respect to the location of the main character. There is evidence to support both points of view.

For example, the work of Morrow and his colleagues (see Bower & Morrow (1990) for a review; see also, Morrow, 1985a; Morrow, 1985b; Morrow, 1994; Morrow et al., 1987; Morrow et. al., 1989a; Morrow et al., 1989b) has been extremely influential in understanding the degree to which readers encode spatial details of a text. Across a

number of studies, Morrow and his colleagues have demonstrated that spatial information seems to be an integral component of the situation model. For example, Morrow (1985b) demonstrated that the choice of referent was determined by more than recency of mention. For example, consider the following sentences:

1. Bill walked past the kitchen into the bedroom.
2. Bill was walking past the kitchen toward the bedroom.

The current location of the protagonist was more strongly encoded in the reader's representation than the most recently mentioned location. These results suggest that an understanding of narrative text is more than just an understanding of the text base: the structure of the mental representation is extremely complex with other factors such as foregrounding, prominence and general world knowledge also playing an important role (see also, Rizzella & O'Brien, 1995). Further, the results of this experiment demonstrated that readers were often aware of the spatial location of the protagonist in the text.

In a related set of experiments, Morrow and his colleagues introduced a new paradigm to investigate situation models (Bower & Morrow, 1990; Morrow et al., 1989a; 1989b; Morrow et al., 1987). In a typical experiment, participants were presented with a map of a spatial layout (e.g., a research lab) which they were required to memorize. They then read a story describing a main character moving through the layout. At various points during the presentation of the text, word pairs appeared on the screen and participants verified whether the two objects were from the same room or different rooms in the originally memorized layout. Morrow et al. (1987) found that participants responded fastest to objects that were located in the same room as the current location of the main character. In addition, verification time increased as the distance between the location of

the protagonist and the room that contained the objects increased. Morrow et al. (1989) also found that if a narrative described a protagonist as moving from one location to another through an unmentioned path room, participants were faster to recognize information from the path room than information from an unmentioned room. This is strong evidence that the reader develops a situation model that includes spatial information and is able to use that to access information that is not explicitly stated in the text (e.g., the location of objects with respect to the current location of the main character).

Morrow et al. (1989a) also found that if the protagonist thinks about a different location than their current location, readers were faster to verify probes from the room they were thinking about rather than probes from the same room as the protagonist. For example, if participants were presented with the sentence, "As Wilbur looked around the library, he thought about the laboratory," they were faster to respond to information about the laboratory than information about the library. Taken together, these results suggest that readers are aware of the location of the main character as well as the location of objects with respect to both the physical and mental location of the main character.

Research by Rinck and Bower (1995) provides converging evidence for this contention. Rinck and Bower (1995) first had participants memorize a map, including the location of rooms and objects located in each room (e.g., Bower & Morrow, 1990; Morrow et al., 1989). However, instead of using on-line probes to determine availability of information, Rinck and Bower had participants read sentences (called motion sentences) that described the main character as moving from one room (the source room), through an unmentioned room (path room) to a final destination (the goal room). Immediately following the motion sentence, participants read a sentence that referred to an

object that was either directly spatially associated with the main character (the goal room), an object from the room they had passed through (the path room), an object from the room they had just come from (the source room), or an object from some other room in the building. They found that participants took longer to read the critical sentence when the object that was referred to was spatially distant from the main character.

A criticism of this experiment might be that when participants read the critical sentence, the lack of an easily available referent caused confusion, which in turn led to the increase in reading time. The narrative did not seem to flow naturally from the body of the text to the motion sentence to the critical sentences. To counter such a claim, Rinck and Bower (1995) presented a second experiment that included filler material to smooth the transition to the critical regions. Despite the fact that the information flowed more naturally, participants still took longer to read the critical sentences when they referred to objects that were farther away from the main character.

Another criticism of this research might be that the results could be due to the order in which participants learned the rooms and objects. Perhaps priming between rooms give rise to difficulty in resolving the anaphor. Because the rooms were learned in a particular order, presentation of information from one room might prime information in the unmentioned path room. To examine this issue, Rinck and Bower (1995) presented participants with the rooms to memorize; however, participants now learned the rooms randomly. If the results were due to priming between adjacent rooms, there should not be a difference in resolving anaphors: participants should not have the priming information available when studying rooms in this manner. However, if the results were due to

participants developing a spatial model of the text, the results from this experiment should be identical to those of the previous experiments.

Rinck and Bower (1995) found that the results from this experiment were identical to those found previously by Morrow and his colleagues (e.g., Bower & Morrow, 1990; Morrow et al., 1987; 1989a; 1989b). It seems that information concerning the location of the main character, as well as the location of objects with respect to the location of the main character is continually available to the reader during comprehension. The fact that reading times for critical sentences referring to information from the unmentioned path room were faster than reading times for critical sentences referring to information from other rooms strengthens this argument by demonstrating that the situation model plays a larger role in the accessibility of information than text-base information (e.g., Morrow, 1985b).

In a conceptually related study, Haenggi et al. (1995) attempted to replicate and extend the work of Morrow and his colleagues. In this research, Haenggi et al. (1995) first presented participants with map of a castle to learn. After learning the map, participants were presented with a text to read. Embedded within each text was a series of probes. Similar to the design of Morrow and his colleagues, the task was to determine if the probes were located in the same room or different rooms on the map. Replicating Morrow, Haenggi et al. found the now familiar distance effect; that is, objects that were located in the same room that the main character was in were responded to most quickly. Again, the results demonstrated that participants were aware of the spatial location of the main character as well as the location of objects with respect to the location of the main character.

However, there are methodological problems associated with all the research discussed to this point: that is, prior to reading the text, participants were first required to memorize a map. Such a situation encourages the reader to focus a great deal of attention on spatial details such as the location of the main character as well as the location of objects with respect to the location of the main character. Typically, readers do not have the advantage of a spatial layout prior to reading a text. Thus, although the evidence seems to indicate that readers can develop and utilize a detailed situation model that includes spatial information, it also seems that explicit experimental manipulations are required to do so.

To answer such a criticism, Haenggi et al. (1995) presented participants with lists of rooms and objects to learn. Thus, instead of memorizing a map, participants were now faced with memorizing verbal information. Again, participants were presented with a passage as well as the familiar probes. The results were similar to previous results in which participants had first learned map, suggesting that participants were able to use the information learned verbally to construct and access a spatial situation model. Further, by creating such a model, readers were able to not only keep track of the location of the main character; they were also able to keep track of the location of objects with respect to the current spatial location of the main character. However, the problem with this research is that participants still had to memorize a spatial layout prior to reading the text. Again, the researchers provided the reader with an enriched knowledge base to draw from during the processing of the narrative.

A different perspective on how readers utilize spatial information is provided by later work by Morrow and his colleagues (e.g., Gray Wilson et al., 1993; Morrow &

Clark, 1988; Morrow, 1994) who have recently argued that readers develop and use a spatial model that would include information surrounding the location of the main character only under certain circumstances (Morrow, 1994; see also, Morrow, 1990). These models may play an essential role in developing the final situation model, but spatial information, including the spatial location of objects surrounding the spatial location of the main character, is only going to be strongly encoded or focused on when the text or the experimental instructions encourage the reader to do so. Specifically, Morrow (1994) argued that readers create a situation/spatial model only under the following conditions: when the text provides sufficient information (cf. Mani & Johnson-Laird, 1982); when the text organization matches knowledge organization (for example, the text describes a spatial layout that is consistent with a typical layout experienced in the world); when readers have sufficient cognitive resources to encode all the spatial details; and when they serve the reader's purpose or strategy (cf. Gray et al., 1993).

To examine some of the issues described above, Gray Wilson et al. (1993) attempted to replicate work done by Morrow. After failing to do so across a number of experiments, they discovered that the types of probes presented during the testing phase determined whether or not readers developed a complete spatial model. Specifically, unless readers were presented with a probe that strongly encouraged them to focus on spatial information (e.g., a probe that required them to respond to whether or not the protagonist was in the same room as an object), they were unlikely to do so. Again, this suggests that the development of a memory representation that contains detailed spatial information is highly dependent on the strategies that participants use to initially encode that information.

The work by Morrow and his colleagues has made valuable contributions to the literature on spatial information. Specifically, it seems that under a variety of conditions, readers are continually aware of the spatial location of the main character. However, the results are qualified by some methodological issues. Because such a situation encourages the reader to focus extensively on spatial information, it must be considered to be an optimal situation for demonstrating the availability of spatial information. A goal for researchers more recently has been to determine if readers develop a situation model that includes spatial details of a text in the absence of pre-memorizing a map.

For example, Morrow (1990) has provided evidence suggesting that the construction of the situation model includes information describing the spatial location of the main character even in the absence of a pre-memorized map. Further, that information is derived from the description of motion through an environment. In this experiment, Morrow had participants read texts describing a main character moving through an environment. He then had participants tell the researcher where the main character was. Readers tended to combine the grammatical information with information from general world knowledge to monitor the location of the main character as he or she moved through the simple spatial layout. Thus, this evidence seems to suggest that readers do focus on the spatial location of the main character.

Perrig and Kintsch (1985) provided additional evidence to suggest that readers can construct a situation model complete with spatial details without prior learning of a map. In their experiments, Perrig and Kintsch (1985) had participants read one of two informationally equivalent descriptions of a town: a survey text that emphasized the spatial information in geographic terms or a route text which emphasized spatial information that

would be consistent with directions provided to someone about how to get from one place to another in the town. Participants were then asked to recall and draw inferences about the text. Perrig and Kintsch (1985) found that recall for the text was good under both conditions, and concluded that participants must be constructing a text-base level representation. However, participants had difficulty drawing inferences (e.g., How to get from one place to another when that specific detail had not been presented as part of the text). Perrig and Kintsch argued that this result may be due to the complexity of the materials.

To test this, Perrig and Kintsch (1985) simplified their materials and performed the experiment again. They found that, overall, readers were much more likely to draw the desired inferences. This was especially true when participants had previously been presented with the route version of the materials. Perrig and Kintsch (1985) argued that with less complex materials, participants were able to develop a situation model in addition to the text-base representation. Consequently, inferences were now easier to draw.

Perrig and Kintsch (1985) found that readers were able to draw inferences about the spatial location of objects within the text; however, these inferences were drawn only when the text was relatively simple. Thus, under optimal conditions, in which spatial information is emphasized and the text is relatively simple, readers can draw spatial inferences. Because readers only drew those inferences when the text was simplified, it can be assumed that developing a spatial representation is an attention demanding task. Unless readers allocate sufficient attentional resources to the task, the spatial model will be relatively incomplete. When the text is complex, readers may not be able to focus on all

the presented spatial information. Presumably, then, except under certain circumstances, readers are not likely to focus on the spatial details of a text.

To further examine some of these issues, Taylor and Tversky (1992) adopted the same general procedure as Perrig and Kintsch (1985) and presented participants either with either a route or survey description of a neutral environment. They then had participants answer questions that accessed either verbatim text information or inference information. Subjects responded more quickly to verbatim questions than inference questions in both conditions; the inferences required additional processing time and resources for the readers to construct. Again, this suggests that readers are not going to construct a representation of the specific details of the location of objects in the text unless the experimental conditions are highly conducive to doing so.

Taken together, the results from Perrig and Kintsch (1985) and Taylor and Tversky (1992) suggest that readers can be made aware of information that surrounds the location of the main character. However, a qualification is that spatial information needs to be emphasized within the text as well as simple enough such that the reader has sufficient attentional resources to encode the spatial details (e.g., Morrow, 1994). Taylor and Tversky (1992) argued that with their materials, spatial information was emphasized and thus was encoded strongly into memory. Perrig and Kintsch (1985) provided participants with simplified texts to allow them to develop a situation model. An additional condition that needs to be met to develop an accurate spatial representation is that information must be both well organized and should describe only one spatial layout (e.g., Ehrlich & Johnson-Laird, 1982; Mani & Johnson-Laird, 1982). Both experiments described above met those criteria (see also, Franklin, Tversky & Coon, 1992).

The question of whether or not readers focus on the location of objects with respect to the spatial location of the main character during the reading of normal text is an important one. Typically, texts are not specifically designed to encourage the reader to develop a detailed spatial model, nor do readers usually have a map available to learn prior to reading the text. However, if spatial information is an important component of the situation model, readers should focus on spatial details and information from general world knowledge should be available to the reader regardless of the form of the text. According to the Construction-Integration model, information that is related to explicitly stated text information should become active (e.g., Kintsch, 1988); further, if it is focused on during reading, it should be more accessible to the reader. However, during the past several years, the research on this issue has not yielded consistent results: Some researchers find that readers are aware of much of the spatial information that surrounds the main character (e.g., Bower & Morrow, 1990; Glenberg et al., 1987; Haenggi et al., 1995; Rinck & Bower, 1995), while others have found very little evidence that readers pay any attention to the spatial details of the main character's current location (e.g., O'Brien & Albrecht, 1992; de Vega, 1995; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994; Zwaan, Magliano, & Graesser, 1995).

An early study that examined this issue was performed by Glenberg et al. (1987) who demonstrated that readers were sensitive to information that was spatially relevant to the protagonist's current spatial location without the reliance on a pre-memorized map.

For example, consider the following sentences:

1. John was preparing for a marathon in August.
- 2a. After doing a few warm-up exercises, he put on his sweatshirt and went jogging.
- 2b. After doing a few warm-up exercises, he took off his

sweatshirt and went jogging.

Subjects read sentences such as these and were then presented with probe words to verify (i.e., SWEATSHIRT). If the information was spatially associated with the protagonist (sentence 2a) participants were faster to respond than if the word was spatially dissociated from the protagonist (sentence 2b).

Glenberg et al. (1987) also wanted to determine the role of foregrounding of text elements in developing a situation model. To address this question, participants read passages, such as the following:

1. Warren spent the afternoon shopping at the store.
- 2a. He picked up his bag and went over to look at some scarves.
- 2b. He set down his bag and went over to look at some scarves.
3. He had been shopping all day.
4. He thought it was getting too heavy to carry.

If foregrounding of information within a text was controlled by simple text-base characteristics, readers should have had an equally easy or difficult time reading sentence 4, despite the fact that the pronoun "it" was separated from its referent by a filler sentence (3). However, if the situation model controls foregrounding, readers should have had a difficult time reading sentence 4 only when the protagonist and the object were dissociated (e.g., sentence 2b). Glenberg et al. (1987) found that participants had a more difficult time resolving the pronoun when the object referred to was spatially dissociated from the main character than when it was associated, suggesting that the situation model controls foregrounding. In addition, Glenberg's results also suggest that readers combine the information explicitly stated in the text as well as information from general world knowledge to incorporate spatial information into the situation model. That information

will presumably include the location of the main character as well as the location of objects with respect to the location of the main character.

O'Brien and Albrecht (1992) have also provided evidence that readers are aware of the spatial location of the main character while reading narrative texts in the absence of a map. In their experiment, participants read texts that described a protagonist who was either inside or outside a health club. Later, participants read a target sentence that described the protagonist as moving in a direction that was either consistent or inconsistent with the originally stated spatial location. O'Brien and Albrecht (1992) found that when the sentence described the protagonist as moving in a direction that was inconsistent with the originally stated location, reading times increased, suggesting that readers were aware of the initial and final locations of the main character.

However, in a second experiment, they presented participants with passages that described a second character moving in a direction that was either consistent or inconsistent with the original location of that character, according to the point of view of the protagonist. When participants were explicitly told to view the situation from the point of view of the main character, reading times increased when the information was inconsistent with the previously presented spatial information. However, only when participants were told to read from the perspective of the main character did they notice the inconsistency. This suggests that although readers may be aware of the spatial location of the main character, additional spatial details, such as the location of objects with respect to the location of the main character, may not be available to the reader unless the reader is focused on those details.

Recent work by Zwaan and van Oostendorp (1993) supports this contention. Zwaan and van Oostendorp (1993) argued that readers have the option of creating a spatial representation. Further, the representation can take one of four forms: an analog image; an integrated spatial model; a relevance based situation model; or a propositional text base. The analog model would predict that readers develop a detailed, image-like representation of space. Because of the resources such a representation would require, this is not likely to be the default strategy for most readers. The integrated spatial model would predict that spatial details, such as relative position of objects surrounding the focus of the reader, would be preserved, but metric distance would not. This is more tenable, but would still require a large amount of resources. The relevance-based spatial model would predict that readers develop a spatial model when the information is directly related to the overall representation of the gist or meaning of the story. That is, when it is important to focus on spatial information, readers will do so. Otherwise, it is not an integral component of text comprehension. The propositional text base model predicts that readers do not construct spatial models. This is an extreme view that does not seem to have much support. The goal of Zwaan and van Oostendorp's research was to determine which model most accurately described the actual processes used by participants during the reading of naturalistic texts.

To examine this issue, Zwaan and van Oostendorp (1993; see also, Zwaan & van Oostendorp, 1994) had participants read texts drawn from literature. The stories chosen contained a great deal of spatial detail. A typical story was a detective novel describing in great detail the layout of objects at a murder scene. Immediately after reading such texts, participants were presented with sentences that required spatial inferences (e.g., the

location of an object with respect to another object, when that relation had not been explicitly stated previously). Zwaan and van Oostendorp found that participants were not very good at drawing spatial inferences about the relative location of objects surrounding the main character. If readers were developing a detailed spatial representation (such as the analog or integrated spatial models would predict), the level of performance presumably would be much better. However, Zwaan and van Oostendorp did find that when participants were told to pay attention to spatial details in the text, performance on spatial inference questions increased, as did overall reading time (as the relevance based spatial model would predict)(see also, Geisen & Peeck, 1984). They argued that by telling readers to focus on spatial details, they were increasing the amount of attention paid (i.e., the focus) to such information. The increase of attention provides the reader with the ability to encode more spatial information into the developing situation model. When presented with the spatial inference question, participants were able to perform more accurately. Thus, according to Zwaan and van Oostendorp, readers form a relatively limited spatial representation unless explicit experimental instructions are provided that would require the development of a more detailed spatial memory representation.

A recent series of experiments by de Vega (1995) provides converging evidence that readers monitor the spatial location of the main character, but that they are not likely to focus on the spatial location of objects with respect to the spatial location of the main character. de Vega presented participants with passages that described a spatial location with two distinct areas (e.g., outside/inside; upstairs/downstairs). Subjects read narratives such as the following:

Carmen likes to walk around in the museum area. The museum has a free entrance so that people can explore the past. The museum has a famous room with

very well preserved Egyptian mummies. In the street, just in front of the museum, many pigeons came, because people use to feed them. Carmen went into (went out of) the museum and walked a few steps. She approached the mummies (pigeons) quietly.

In this experiment, participants were presented with either a consistent version (e.g., Carmen went into the museum; She approached the mummies quietly) or an inconsistent version (e.g., Carmen went into the museum; She approached the pigeons quietly). de Vega found that when the second sentence described the main character as acting in a way that was spatially inconsistent with the final spatial location of that character, reading times increased (see also, O'Brien & Albrecht, 1992).

In a second set of experiments, however, de Vega (1995) demonstrated that if a cue was not presented to strongly encourage the participant to update the situation model and include spatial details of the text, readers did not do so (e.g., Myers, O'Brien, Albrecht & Mason, 1994). For example, consider the following passage from de Vega (1995):

Maria was visiting an Italian town for the first time.
In one of the squares there is a bronze sculpture of a
soldier riding a horse. On one side of the square there
is an old palace. Inside the palace there is a
luxurious marble staircase. Maria went into (went out
from) the palace and she walked a few steps. She
looked around with admiration.

Immediately after reading the final sentence, participants were presented with a probe word to verify. For example, the probe words for the presented text was either SCULPTURE or STAIRCASE. If readers monitor the location of objects with respect to the location of the main character, they should respond more quickly to objects that are consistent with the current location of the main character (e.g., Maria went into the palace. Probe: STAIRCASE). However, de Vega found no evidence for this. Response

times to the probes were equally fast in both conditions. However, when participants were presented with a cue, such as a phrase describing the main character as looking around with admiration, participants do respond more quickly to the consistent probe.

From the current review, it should be apparent that although the evidence is clear that readers are aware of the spatial location of the main character, the evidence is less compelling in terms of the role that spatial details play in the development of the situation model. The goal of the current dissertation is to further understand the role of spatial information. Specifically, I am interested in two issues: first, under what conditions do readers focus on and reactivate previously mentioned spatial information; second under what conditions do readers have access to spatial information that had not previously been presented in the text. Presumably, according to the construction-integration model, information from general world knowledge is incorporated into the situation model. If it is strongly encoded (e.g., carried over a number of processing cycles) it should be more accessible than information that was not strongly encoded. The hypotheses for the experiments are consistent with those proposed by Zwaan and van Oostendorp (1993). That is, readers will only focus on and reactivate spatial information when the situation requires or encourages it. Otherwise, spatial information will play a very limited role in the situation model.

SECTION V. EXPERIMENTS

Thus, four experiments were designed to examine the two specific issues outlined above. Experiment 1 was designed to assess whether or not readers would focus on and reactivate spatial information as a function of explicit experimental instructions. In one condition, readers will be told to focus on the spatial details of the text while in the other condition, readers will be told simply to read for comprehension. If readers require explicit experimental instructions to focus on and reactivate spatial details (e.g., Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994), spatial information will only be reactivated when readers are told to do so.

Experiment 2 was designed to determine ease of integration of spatial information as a function of experimental instructions. A critical sentence will be presented that will describe the protagonist as interacting with an object that is either consistent or inconsistent with the final spatial location. If readers require explicit experimental instructions to focus on spatial information, they should only experience comprehension difficulty during integration when explicitly told to focus on spatial information.

Experiment 3 was designed to determine if focus on spatial information could be controlled within the text by making it the goal of the protagonist to focus on spatial information. The methodology of Experiment 1 is replicated with re-written texts to implicitly encourage the reader to focus on the goals of the protagonist. Finally, Experiment 4 was designed as a replication of Experiment 2 with the re-written passages to encourage the reader to focus on the goals of the protagonist.

As described above, two dependent measures will be used: naming time and reading time. Potts, Keenan and Golding (1988) (see also, Keenan, Golding, Potts, Jennings & Aman, 1990) have argued that naming time is a good measure of current level of activation of a concept. Thus, in the current experiments, readers will be presented with a concept that represents information surrounding the location of the main character. If the readers are focused on the spatial details of the text, that information should be more available to them, and thus named more quickly. If readers are not focused on spatial information, there should be no difference in level of activation and thus, naming times should not be affected.

Reading time is also used as a dependent measure in the current dissertation. Reading time provides a measure of integration of current information with information that has preceded it (e.g., Kintsch, 1988; Haenggi et al., 1995). If participants have an easy time integrating, reading times should be fast. If participants encounter difficulty, reading times should be slower (e.g., Albrecht & O'Brien, 1993; O'Brien & Albrecht, 1992; O'Brien & Myers, 1985). Thus, this dependent measure should provide information concerning how easily a critical sentence is integrated into the developing representation (e.g., Kintsch, 1988).

Experiment 1

Whether or not readers focus on spatial information while developing a situation model is currently under debate (e.g., Bower & Morrow, 1990; de Vega, 1995; Graesser, et. al, 1994; Rinck & Bower, 1995; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994). The results of some experiments suggest that readers develop a spatial model containing details concerning the location of objects with respect to the current location of the main character (e.g., Bryant, 1992; Rinck & Bower, 1995). In contrast, others suggest that the reader's concern with spatial information is limited to the spatial location of the main character (e.g., Albrecht & O'Brien, 1992; de Vega, 1995). For example, as described previously, de Vega (1995) demonstrated that if readers were presented with a cue to prompt re-activation of a previously presented spatial environment, they responded more quickly to a probe that was consistent with that environment than to an inconsistent probe. When the reinstatement cue was not presented, participants responded equally quickly to both consistent and inconsistent probes. The results of this experiment suggested that participants do not typically focus on the location of objects with respect to the location of the main character except when provided with an experimental manipulation that strongly encouraged them to do so.

Although de Vega's evidence is relatively compelling, there are several methodological concerns which render his results difficult to interpret. First, de Vega required participants to read very short texts. It may be that a situation model requires longer texts to develop (e.g., Morrow, 1994). In addition, each participant read the text at the same, experimenter controlled rate (600 msec per word or two words). By not allowing participants to control rate of presentation it may have been more difficult for the

reader to focus on spatial information while encoding text information, and resulting in an incomplete situation model.

Thus, Experiment 1 was designed as a conceptual replication of experiments by de Vega (1995), with a modified set of materials to eliminate some of these methodological problems. Longer passages were written (approximately 250 to 300 words), which were designed to allow readers time to develop a situation model. For example, consider the passage presented in the Table 1. The passage describes a main character, Tony, as moving through a spatial environment (a supermarket). When Tony enters the supermarket, he notices a bakery. He enters the bakery notices a number of things inside, including a juice rack. Tony leaves without buying juice. Later, Tony realizes that he has enough money left over to buy some juice. He walks back to the juice rack. However, in doing so, it is implicit that he is also going back to the bakery. If readers focus on spatial information, according to the Construction-Integration model (Kintsch, 1988), the concept BAKERY would more likely be reactivated than would a neutral probe, such as DOOR, because it is consistent with the final spatial location of the main character and it should be strongly encoded into the representation. Alternatively, if readers are not focusing on the spatial details in the text, BAKERY should be no more likely to be reactivated than DOOR, as neither would be retrieved after reading the final sentence. Thus, naming times should not differ.

In the current experiment, text presentation was self-paced, with only one line of text available to the reader at any one time. Each passage was followed by a probe word that was named. If spatial information becomes reactivated, readers should respond more quickly to spatially associated probes than the neutral probes.

Table 1

Example passage from Experiment 1 and 2.

Tony had just been transferred to Minnesota and was busy getting settled into his new apartment. After he finished unpacking, he decided to go to the supermarket and pick up some groceries. He got into his car and drove downtown to the supermarket. As soon as Tony entered the supermarket, he noticed a large bakery off to his right that had been set off from the rest of the store by a large partition. It appeared to be its own separate shop within the supermarket. In fact, there was a door between the bakery and the rest of the store. Tony went through the door and looked around. He saw that inside were all different kinds of pastries and baked goods to choose from. He also noticed a large juice rack in the corner that contained all the juice sold in the store. Tony quickly glanced at the rack, but decided to wait and see if he had enough money left over after he had purchased everything he needed. However, while there, Tony picked up a package of muffins and bagels. He left and walked out to the main store's dairy case for some eggs and milk. Tony also really enjoyed cold cereal, so he went to the cereal aisle and grabbed three boxes. At the opposite end of the store, Tony found the deli, where he picked up cold cuts for sandwiches. After he left the deli, Tony added up his grocery bill and realized that he still had enough money left over to buy juice. He quickly headed back to the juice rack and grabbed a bottle.

Associated probe: bakery

Neutral probe: door

Experiment 2

Associated sentence:

He also grabbed a cake from the shelf.

Dissociated sentence:

He also grabbed a gallon of ice cream.

Experiment 1 consisted of two parts, with half the participants being told to focus on the spatial details of the text (e.g., Albrecht et al., 1995; Giesen & Peeck, 1984; O'Brien & Albrecht, 1992; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994) and the other half being told to read for comprehension. If readers require specific instructions to prompt reactivation of spatial information (as argued by Giesen & Peeck, 1984; O'Brien & Albrecht, 1992; Zwaan & van Oostendorp, 1993; Zwaan et al., 1995), the results of the two experiments should differ; when told to read for comprehension, readers should name the spatially-associated probes as quickly as the neutral probes. However, when told to pay attention to the spatial details, readers should more strongly encode spatial details into memory and thus should name spatially associated probes faster than neutral probes.

Method

Participants. 40 University of New Hampshire undergraduates enrolled in Introductory Psychology participated in exchange for course credit.

Materials and design. 10 passages describing a protagonist moving through a spatial environment were generated. Each passage was composed of four sections: an introduction that described the initial spatial location; a spatial description of a particular target location; filler material; and a relocation sentence, shifting the main character back to a target location, without explicitly re-mentioning the location.

Following each passage, participants were presented with a probe word to name. The probe was either the final spatial location of the protagonist, or a neutral word that was close to the spatially associated probe in the text's surface structure, but that did not

contain spatial information. Finally, each passage was followed by a comprehension question to ensure that participants were reading the text carefully.

Two material sets were generated; in half the passages participants named a probe word that was associated with the final spatial location of the main character and in the other half participants named a neutral probe. Participants were randomly assigned to one of two material sets with the restriction that an equal number of participants were assigned to each set.

Procedure. Participants were tested in an experimental session that lasted approximately thirty minutes. All materials were presented on a video monitor controlled by a Zenith Z-100 microcomputer. Prior to the start of the experiment, half the participants were told that while reading each text, they were to pay attention to the spatial details of the text. Specifically, they were told, "In the texts you are about to read, it is very important that you pay attention to the spatial details of each story. That is, you should pay attention to information concerning the location of information mentioned in the text. You should use this strategy for each individual text." The remaining participants were told that they were to read the texts for comprehension. They were told that answering the question was the most important component of the experiment and that they should be ready to answer as quickly and accurately as possible.

All participants were instructed to rest their right thumb on a line-advance key, their right index finger on a "yes" key and left index finger on a "no" key. Each passage began with the word "Ready" in the center of the screen. When participants were ready to begin, they were instructed to press the line-advance key. This erased the word "Ready" and presented the first line of text on the screen. Participants were instructed to read each

line and when they had understood it, to press the line-advance key. This erased the current line and present the next line. The time between key presses was considered reading time.

After reading the last line of the passage and pressing the line-advance key, a cue (XXX) was presented on the screen for 500 milliseconds followed immediately by the probe word. Participants were instructed to name the probe word as quickly as possible. Naming the probe word activated a voice key that erased the probe word from the screen. Time to name the probe was recorded by the computer.

Immediately after the response to the final probe, the word "Question" was presented for 2000 milliseconds. Following this cue, participants saw the cue "???????" on the screen for 750 milliseconds. The cues served to inform participants that a comprehension question followed. Participants responded to the question by pressing the "yes" or "no" key. Time to respond to the comprehension questions was also recorded. Each session began with three practice passages to ensure that participants understood the procedure.

Results and discussion

Mean naming times for both associated and neutral probes were recorded. Naming times that were three standard deviations from the mean were discarded, which eliminated less than 2% of the data. In what follows, F_1 refers to tests against an error term based on subject variability and F_2 refers to tests against an error term based on item variability. All analyses are significant at the .05 level unless otherwise indicated.

The mean naming times for Experiment 1 are presented in Table 2. An ANOVA was performed to determine if there was a significant interaction between experimental

Table 2

Mean naming time (in milliseconds) and standard deviations (in Parentheses) for probe concepts from Experiment 1.

Naming time for probe word		
	Associated	Neutral
Explicit instructions	509 (76)	522 (74)
No instructions	524 (85)	519 (76)

instructions and probe condition; the interaction was significant, $F_1(1,37) = 4.94$, $MSe = 317$; the effect did not reach significance in an analysis based on items, $F_2(1,17) = 1.1$, $MSe = 1413$, $p = .3$.

Planned comparisons revealed that when participants were told to focus on the spatial details of the text, spatial probes were named significantly faster than neutral probe words, $F_1(1,18) = 7.90$, $MSe = 194.77$. However, the difference did not reach significance in an analysis by items, $F_2(1,8) = .514$, $MSe = 1093$, $p > .05$. Response rate to comprehension questions was 96%.

In contrast, when participants were not presented with explicit experimental instructions to focus on the spatial details of the text, naming times for spatial location probes and neutral probe words did not differ, $F_1(1,18) = .66$, $MSe = 424.7$, $F_2(1,8) = .51$, $MSe = 1883$, both p 's $> .05$. Response rate to comprehension questions was 96%. Finally, there were no differences between spatial or neutral probes as a function of experimental instruction condition ($t_{38} = .582$ for spatial probes; $t_{38} = .115$ for neutral probes; both p 's $> .05$).

The current results are consistent with the results of Zwaan and van Oostendorp (1993) (as well as Geisen & Peeck, 1984; O'Brien & Albrecht, 1992) using a different dependent measure. They demonstrated that when readers were explicitly informed to focus on particular details of a text, they were able to do so; when reading for comprehension, participants were not likely to focus on the spatial details of the text. Thus, although readers do have the ability to focus on and strongly encode the location of objects with respect to the location of the main character, it does not appear that they do so unless explicitly told to do so.

Experiment 2

Experiment 1 demonstrated that readers can focus on the spatial details of the text when provided with explicit experimental instructions to do so. The goal of Experiment 2 was to determine if focus on spatial details provided readers with access to spatially relevant information that had not previously been presented in the text (e.g., Kintsch, 1988; Rinck & Bower, 1995). Although it is generally assumed that general world knowledge is used in combination with explicitly mentioned text information to develop a situation model, little evidence exists to support this contention with regard to spatial information. For example, although de Vega (1995) examined readers' ability to monitor the spatial details of the text, he did not address the accessibility of spatially relevant, but unmentioned, information. Assuming that the development of a situation model includes unmentioned, but contextually relevant information (e.g., Garnham, 1981; Kintsch, 1988), and if readers reactivate the spatial details that are consistent with the final spatial location of the main character while integrating a critical sentence, spatially relevant information should be more available than spatially irrelevant information regardless of whether or not it had previously been mentioned.

For example, again consider the passage in Table 1. Tony enters and leaves a bakery, only to return to it again later. Instead of a probe, participants in Experiment 2 were presented with a critical sentence that was either consistent with the final spatial location (e.g., He also decided to pick up a chocolate cake.) or inconsistent (e.g., He also decided to pick up some ice cream.). The information contained in the critical sentence had not previously been presented in the text (e.g., cake), but was either contextually relevant or irrelevant to the final spatial location of the protagonist. If readers focused on

the spatial details of the text, and contextually relevant information also became available, readers should have had no difficulty reading the consistent critical sentence, as it is consistent with all the previously presented information. However, readers should experience difficulty when the critical sentence describes the main character as interacting with an object that could not possibly be within the current spatial location (e.g. O'Brien & Albrecht, 1992). However, if readers do not focus on spatial details, no reactivation of spatial information should occur and reading times should not differ between the two conditions.

Method

Participants. 40 University of New Hampshire undergraduates enrolled in Introductory Psychology participated in exchange for course credit.

Materials and design. Passages were identical to those used in Experiment 1, with the following modification. Immediately following the motion sentence, a critical sentence was presented that described the protagonist interacting with an object that was either consistent or inconsistent with the current spatial location. The critical sentences varied from 38 to 40 characters in length and appeared on the screen alone. Finally, a closing section was added to ensure that the passages flowed naturally. Participants were randomly assigned to one of two material sets with the restriction that an equal number of participants were assigned to each set.

Procedure. The procedure was similar to Experiment 1. The only difference was that reading time for the critical sentence was recorded and the memory probes were eliminated.

Results and discussion

Reading times for the critical sentence (the sentence that contained either contextually appropriate or inappropriate information) were recorded. Reading times greater than three standard deviations from the mean were discarded, which eliminated less than 3% of the data.

Mean reading times for the critical sentences are presented in Table 3. The interaction between experimental instructions and critical sentence type was significant in an analysis by subjects, $F_1(1,37) = 10.00$, $MSe = 98651$, and approached significance in an analysis by items, $F_2(1,17) = 3.69$, $MSe = 123039$, $p = .07$.

Planned comparisons confirmed that when participants were told to pay attention to the spatial details in the text, reading time for the critical sentences that were spatially consistent with the location of the protagonist were faster than for sentences that were inconsistent with the location of the protagonist, $F_1(1,18) = 16.29$, $MSe = 137712$, $F_2(1,8) = 6.50$, $MSe = 153947$. When participants were told to read for comprehension, reading time for the critical sentences did not differ, $F_1(1,18) = .174$, $MSe = 49977$, $F_2(1,8) = .287$, $MSe = 79964$, both $p > .05$. Response rate to comprehension questions was 95%.

Participants also read the critical sentences more slowly when they were instructed to attend to spatial details than when they were told to read for comprehension, $F_1(1,37) = 9.32$, $MSe = 761394$, $F_2(1,17) = 20.52$, $MSe = 131255$ (e.g., Zwaan & van Oostendorp, 1993). Response rate to comprehension questions was 94%. Finally, reading time varied significantly for both the consistent and inconsistent critical sentences as a function of experimental instruction condition ($t_{38} = 2.20$ for consistent critical sentences; $t_{38} = 3.36$ for inconsistent critical sentences).

Table 3

Mean reading time (in milliseconds) and standard deviations (in Parentheses) for critical sentences from Experiment 2.

Reading time for critical sentence		
	Consistent	Inconsistent
Explicit instructions	2224 (685)	2698 (987)
No instructions	1851 (384)	1880 (456)

As in Experiment 1, explicit experimental instructions encouraged participants to focus attention on spatial information. When participants were presented with either the probe word (Experiment 1) or a contextually relevant critical sentence (Experiment 2) the previously presented spatial information was reactivated and it was able to be integrated during comprehension. However, without explicit experimental instructions, readers do not do so (e.g., O'Brien & Albrecht, 1992).

If reactivation of spatial information is a function of the reader's focus, it may be that a text could be written that would encourage the reader to focus on spatial information without explicit experimental instructions. Thus, if focus is required for spatial information to become reactivated, by encouraging readers to focus on spatial details within the text, participants should reactivate spatial details regardless of explicit experimental instructions. Experiments 3 and 4 test this possibility.

Experiment 3

As described, a possible explanation for participants not reactivating the previously mentioned spatial information when told to read for comprehension may be that there was no reason for the reader to focus on the spatial details of the text. Thus, for Experiments 3 and 4, passages were re-written to increase the degree to which the text encouraged the reader to focus on spatial details; in each passage a special circumstance was presented to encourage readers to focus on spatial details. For example, consider the passage about Tony presented in Table 4. Tony is now only one character in the story. His wife has also moved with him to Minnesota. In addition, the special characteristic is that Tony's wife is terrible with directions, and she asks Tony to pay particular attention to spatial information. The rest of the story is identical to those used in Experiments 1 and 2. As in Experiment 1, participants were required to name a spatially associated probe or a neutral probe.

If focus on spatial details can be controlled by text variables, there should be no difference in the pattern of naming times as a function of experimental instructions. Specifically, when told to read for comprehension, participants should name the spatially associated probes faster than neutral probes. Additionally, when told to pay attention to the spatial details of the text, readers should again name the spatially associated probes faster than neutral probes. However, if the additional information does not increase the focus of the reader on spatial details, or if other processes are required for spatial information to become reactivated and integrated (e.g., Kintsch, 1988), the pattern of results should be identical to Experiment 1.

Table 4

Example passage from Experiment 3 and 4.

Tony and his wife, Tina, had just moved to Minnesota and were busy getting settled into their new apartment. Tony was adjusting well, but Tina, however, had a terrible sense of direction and often relied on Tony's explicit instructions on how to get around. Thus, when Tony decided to go to the supermarket for some groceries, Tina asked him to pay close attention to where different things were. Tony assured her that he would do his best to remember where everything was. Tony got into his car and drove downtown to the supermarket. As soon as Tony entered the supermarket, he noticed a large bakery off to his right that had been set off from the rest of the store by a large partition. It appeared to be its own separate shop within the supermarket. In fact, there was a door between the bakery and the rest of the store. Tony went through the door and looked around. He saw that inside were all different kinds of pastries and baked goods to choose from. He also noticed a large juice rack in the corner that contained all the juice sold in the store. Tony quickly glanced at the rack, but decided to wait and see if he had enough money left over after he had purchased everything he needed. However, while there, Tony picked up a package of muffins and bagels. He left and walked out to the main store's dairy case for some eggs and milk. Tony also really enjoyed cold cereal, so he went to the cereal aisle and grabbed three boxes. At the opposite end of the store, Tony found the deli, where he picked up cold cuts for sandwiches. After he left the deli, Tony added up his grocery bill and realized that he still had enough money left over to buy juice. He quickly headed back to the juice rack and grabbed a bottle.

Associated probe: bakery

Neutral probe: door

Experiment 4

Associated sentence:

He also grabbed a cake from the shelf.

Dissociated sentence:

He also grabbed a gallon of ice cream.

Method

Participants. 40 University of New Hampshire undergraduates enrolled in Introductory Psychology participated in exchange for course credit.

Materials and design. The materials from the first two experiments were re-written so that each contained information designed to increase the focus on spatial information. For example, in the passage in Table 4, the introduction was re-written to include information about Tony's wife, Tina, and her difficulty with directions.

The design was identical to Experiment 1.

Procedure. The procedure was identical to Experiment 1.

Results and discussion

Naming times for both the associated and neutral probe words were recorded. Naming times greater than three standard deviations from the mean were discarded, which eliminated less than 3% of the data. Mean naming times for the both probe types are presented in Table 5.

Experiment 3 replicated and extended the results of Experiment 1. The overall ANOVA again demonstrated a significant interaction between experimental instructions and probe type, $F_1(1,37) = 6.28$, $MSe = 468$, $F_2(1,17) = 1.96$, $MSe = 1027$, $p = .2$.

Planned comparisons confirmed that when participants were told to pay attention to spatial details within the text, they named the associated probes more quickly than the neutral probes, in an analysis by participants, $F_1(1,18) = 10.31$, $MSe = 504$. However, the effect did not quite reach significance in an analysis by items, $F_2(1,8) = 2.82$, $MSe = 1574$, $p = .13$. Response rate to comprehension questions was 95%.

Table 5

Mean naming time (in milliseconds) and standard deviations (in Parentheses) for probe concepts from Experiment 3.

Naming time for probe word		
	Associated	Neutral
Explicit instructions	530 (83)	553 (91)
No instructions	522 (66)	521 (65)

However, contrary to predictions, information embedded within texts designed to increase reader focus, did not appear to increase participants sensitivity to spatial details, $F_1(1,18) = .05$, $MSe = 443$, $F_2(1,8) = .02$, $MSe = 554$. Response rate to comprehension questions was 94%. Finally, naming time for spatial or neutral probes did not vary significantly as a function of experimental instruction condition ($t_{38} = .333$ for spatial probes; $t_{38} = 1.23$ for neutral probes; both p 's $> .05$).

The results of Experiment 3 replicated the results of Experiment 1. That is, when participants were told to pay attention to spatial details in the text, they did so. When told to pay attention to spatial details, the additional degree of focus allowed them to strongly encode the spatial information and allowed this information to be quickly reactivated at the end of the text (e.g., Kintsch, 1988). Thus, when the motion sentence described the main character as moving back to the juice rack, information concerning the bakery also became reactivated. When participants were told to read for comprehension, focus on spatial details presumably increased. However, the spatial information was not reactivated, suggesting the possibility that focus alone does not control the availability of information (e.g., de Vega, 1995; but see also Rinck & Bower, 1995). It may be that in addition to an increase in focus, the integration stage of comprehension also plays a role in whether or not spatial information is reactivated (e.g., Kintsch, 1988; Kintsch, 1992). Experiment 4 tests this possibility.

Experiment 4

Experiment 4 was designed to examine one more possibility of the role that spatial information has on comprehension and memory for text. Although the focus on spatial details was increased in Experiment 3, readers still did not appear to focus on spatial details without explicit experimental instructions. It may be that readers require a cue within the text to force them to integrate the focused-on spatial information (e.g., de Vega, 1995). If readers require a cue to begin the integration phase then perhaps they will integrate spatial information when required to read a critical sentence that implicitly refers to the previously mentioned spatial location. Previous research has demonstrated that when reading a critical sentence that refers back to earlier presented information, participants attempt to maintain global coherence by integrating that sentence into the existing representation. The information is checked at both the local and global level to ensure that it is coherent with the current discourse representation (e.g., Albrecht & O'Brien, 1993; Hakala & O'Brien, 1995; Huitema, et al, 1993; Myers, et. al, 1994). The information is checked against all relevant information; this includes both the current contents of active memory as well as previously presented, but no longer active information from long term memory.

Presumably, the critical sentence will provide additional information that should drive the reader to incorporate the current contents of active memory with related information that came previously. If the reader focuses on spatial information, even in the absence of explicit experimental instructions, reading times to critical sentences should increase when the action described involves having the main character interact with an object that is inconsistent with the final spatial location, as the reader attempts to integrate

that information with previously presented, related information. However, if the main character is described as interacting with a consistent object, participants should not experience comprehension difficulty, and thus, reading times should not increase. To increase the focus on spatial details within the text, the materials from Experiment 3 were again used.

Method

Participants. 40 University of New Hampshire undergraduates enrolled in Introductory Psychology participated in exchange for course credit.

Materials and Design. The materials were identical to Experiment 2, with the additional information included in the materials for Experiment 3. An example passage is presented in Table 4.

The Design was identical to Experiment 2.

Procedure. The procedure was identical to Experiment 2.

Results and Discussion

Reading time for the critical sentence was recorded. Reading times greater than three standard deviations from the mean were discarded, which eliminated less than 3% of the data.

The mean reading times for the consistent and inconsistent critical sentences are presented in Table 6. The interaction between experimental instructions and consistency condition of critical sentence was not significant, $F_1(1,37) = .225$, $MSe = 101557$, $F_2(1,17) = .172$, $MSe = 106275$, both $p > .05$.

Planned comparisons confirmed that when explicit experiment instructions were presented, participants took longer to read an inconsistent critical sentence than a

consistent critical sentence. This difference was significant in an analysis based on subject variability, $F_1(1,18) = 7.54$, $MSe = 85932$, and approached significance in an analysis based on item variability, $F_2(1,8) = 4.48$, $MSe = 86907$, $p < .07$. Response rate to comprehension questions was 96%.

More importantly, when told to read for comprehension, participants took more time to read the inconsistent critical sentence than they did to read the consistent critical sentence, $F_1(1,18) = 8.59$, $MSe = 120764$, and again approached significance in an analysis based on item variability, $F_2(1,8) = 4.80$, $MSe = 138376$, $p < .06$. Response rate to comprehension questions was 96%. Finally, reading times did not vary significantly for the consistent or inconsistent critical sentences as a function of explicit experimental instruction condition ($t_{38} = .704$ for the consistent critical sentence; $t_{38} = .943$ for the inconsistent critical sentence; both p 's $> .05$).

The results of Experiment 4 differed from the results of Experiment 2. Specifically, even when participants were told to read for comprehension, they still detected when the main character interacted with an object that was inconsistent with the final spatial location. This suggests that focus on spatial information can be controlled either by explicit experimental instructions or text manipulations. However, focus on spatial details only seems to have an impact on reading when that information must be reactivated to allow for comprehension (e.g., de Vega, 1995), suggesting that additional processes beyond focusing on spatial details (i.e., integration) is necessary for the reactivation of the previously presented spatial information.

Table 6

Mean reading time (in milliseconds) and standard deviations (in Parentheses) for critical sentences from Experiment 4.

Reading time for critical sentence		
	Consistent	Inconsistent
Explicit instructions	1928 (478)	2182 (576)
No instructions	2037 (498)	2359 (605)

SECTION VI: GENERAL DISCUSSION

Results from the current set of experiments replicated and extended much of the research on the development of a situation model (e.g., Bower & Morrow, 1990; de Vega, 1995; Garnham, 1981; Graesser et al., 1994; Haenggi et al., 1995; McKoon & Ratcliff, 1992; Morrow, 1993; O'Brien & Albrecht, 1992; Singer et al., 1994; van Dijk & Kintsch, 1983; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994) by further specifying some of the conditions under which spatial information is incorporated into the resulting memory representation. Specifically, it appears that spatial information does not play a large role in the comprehension of most narrative texts. This conclusion is consistent with work by Zwaan and van Oostendorp (1993), O'Brien and Albrecht (1992), Rinck and Bower (1995) and Haenggi et al. (1995). The results from the current set of experiments will be discussed within a framework that predicts what information will be reactivated and utilized for comprehension.

While reading, information on which the reader is focused on is more likely to be incorporated into the developing memory representation (e.g., Albrecht, 1993; Anderson, Garrod, & Sanford, 1983; Garrod & Sanford, 1990; Glenberg & Langston, 1987; Kintsch, 1988; McKoon & Ratcliff, 1992; O'Brien & Albrecht, 1992; Rinck & Bower, 1995; Sanford & Garrod, 1981). According to the Construction-Integration model proposed by Kintsch (1988), the more a reader focuses (or attends) on information in the text, the more activation that information will receive during the construction phase and the more likely it will be carried over to the next processing cycle. Thus, the more strongly that information will be encoded into memory. Further, the more strongly that information is encoded, the more likely it will be reactivated during integration (e.g., McKoon & Ratcliff, 1992;

O'Brien, 1995; Rinck & Bower, 1995; Rizzella & O'Brien, 1995). In the current set of experiments, I was interested in the degree to which readers focused on spatial details within the text, and the likelihood that such information would later be reactivated.

To attempt to understand the present results, I will now discuss my findings within the Construction-Integration model (e.g., Kintsch, 1988; Kintsch, 1992). For example, in Experiment 1, participants were presented with a probe word to name that represented information that theoretically would be associated with the final spatial location of the main character. If the reader focused on spatial information, those details should have received more activation during initial encoding (similar to when told to memorize a map). At the end of the text, the previously presented spatial information should have become quickly reactivated through a passive, "dumb" process during the construction stage. Thus, the spatially associated probe should have been named more quickly than the neutral probe.

When participants were told to focus on the spatial details of the text, the final sentence of the passage (e.g., Tony quickly walked back to the juice rack...) prompted reactivation of the spatial information. Because the reader was told to pay attention to the spatial details, focus on spatial details increased and that information was quickly reactivated at the end of the passage. The information was both strongly encoded and readily available to the reader at the end of the passage (e.g., Kintsch, 1992). Further, assuming readers were doing as they were instructed, they focused on spatial details throughout each individual text.

In contrast, when participants were told to read for comprehension, the final sentence did not prompt reactivation of the spatial information. Presumably, there was no

reason for readers to focus on the spatial details of the text. During the construction stage, there was little reason for the reader to activate that information more than any other information. Thus, it was less likely to be carried over to the next processing cycle and subsequently, less likely to be available at the end of the text. Consequently, there was little reason for that information to become reactivated at the conclusion of the text. Although the spatial information was encoded to some degree, it was not sufficient for reactivation.

Presumably, the results from Experiment 1 were due to the reactivation of the spatial information and the strategy of the reader rather than a simple anaphoric reference to text-base information (as in Rinck & Bower, 1995). If participants were simply drawing an anaphoric inference within the text-base representation, naming times should not have differed between spatial and neutral probes. The probes were drawn from approximately the same location within the text, and previous research (e.g., McKoon & Ratcliff, 1980b) has demonstrated that when antecedents are drawn from approximately the same location in the text, retrieval times do not differ significantly. Further, if readers were merely drawing an anaphoric reference, naming times should not have differed between experimental instruction conditions. Thus, it appears that when participants were told to pay attention to spatial details in the text, they did so, and as a result, previously presented spatial information became available.

Experiment 2 was designed to determine if readers would notice inconsistencies between the current spatial location of the main character and information that should or should not be located within that environment. According to the theories describing the development of a situation model (e.g., Kintsch, 1988), general world knowledge that is

associated with the current contents of active memory should also become available to the reader during the construction stage. However, results from Experiment 1 (as well as de Vega, 1995; O'Brien & Albrecht, 1992) suggested that spatial information would not become reactivated unless the reader focused on such information during encoding (i.e., through explicit experimental instructions). The results of Experiment 2 demonstrated that the spatial details only became reactivated when the explicit experimental instructions were provided to the readers. Thus, when participants were told to read for comprehension, they apparently did not focus on the spatial information. Consequently, the information was not readily available and was not reactivated while integrating the critical sentence (e.g., O'Brien & Albrecht, 1992).

Again, however, when the explicit experimental instructions were presented participants focused on the spatial details of the text. Because of the additional focus and the experimental instructions, spatial information was more likely to be carried over across a number of processing cycles, and thus became reactivated at the end of the passage and was used to integrate the critical sentence. When the critical sentence referred to an object that was consistent with the location of the main character (e.g., He also decided to pick up a chocolate cake), comprehension continued without disruption. However, when the object was not available in the spatial location that was accessed (e.g., He also decided to pick up a gallon of ice cream), comprehension difficulty occurred (e.g., Albrecht & O'Brien, 1993; Hakala & O'Brien, in press; O'Brien & Myers, 1985). Thus, reactivation of spatial information was a function of focus and the strategy of the reader; only if readers were explicitly informed to focus on spatial details were they aware of the inconsistencies during integration.

Experiment 3 was designed to determine if the degree of focus and the comprehension strategies of the reader could be manipulated within text itself. That is, could texts be written that emphasize spatial details to such a degree that readers would focus on and use that information without the explicit experimental instructions. If focus was increased sufficiently, and participants adopted the strategy of using that spatial information to integrate incoming information, the final sentence of the passage should have provided access to the initial spatial information and caused it to become reactivated, regardless of experimental instructions. However, this result did not obtain. Again, readers only responded more quickly to associated probes when provided with explicit experimental instructions. This suggests that even when focus is increased within the text, spatial information still does not become reactivated. It appears that focus alone does not control the degree to which spatial information is utilized during reading. Presumably, during the construction stage, activation of the spatial information was increased. However, the final sentence did not require reactivation of the spatial information for coherence to continue (i.e., to integrate the final sentence). Thus, although the spatial information may have been carried over a number of processing cycles, there was no need for this information to be reactivated at the end of the text.

Experiment 4 was designed to determine if readers were presented with texts that invited them to focus on spatial details, would that make spatially relevant, but not explicitly mentioned information more available during the integration stage. The results of Experiment 4 demonstrated that the combination of the increase in focus, the embedded spatial information as well as a cue to complete global processing did encourage readers to monitor the spatial details of the text regardless of explicit experimental instructions (e.g.,

de Vega, 1995). It appears that the additional focus placed on the spatial details increased the level of activation during the construction stage of comprehension. The previously presented information was necessary for integration of the critical sentence, and thus was reactivated. When the participant read the critical sentence, the inconsistency was noticed and problem solving strategies were required to allow comprehension to continue.

This argument is in line with that posed by Zwaan and van Oostendorp (1993) and O'Brien and Albrecht (1992) who argued that readers are only concerned with spatial information under certain conditions. In addition, it also supports the contention of McKoon and Ratcliff (1992) who argue that readers only draw global inferences when the information is "readily available" or necessary because of a global coherence break. The contribution of the above results is that they suggest that it may be that spatial information is focused on at a low level, but whether or not it becomes reactivated and integrated is a function of both the focus on spatial details as well as whether or not that information is required for integration. Specific to the current results, spatial information may be focused on during encoding (both through experimental instructions and text manipulations), but whether or not it becomes reactivated is a function of whether or not the information is necessary for maintaining coherence.

To further understand how readers were interpreting my passages, subjective data were collected. Specifically, during debriefing, several participants were asked about their general impressions of the passages (cf., Anderson & Pichert, 1978). I found that participants were aware of the spatial location of the main character; however, consistent with the reaction time results, participants were less likely to be aware of the location of objects with respect to the main character. They were, however, more likely to be aware

of the location of objects with respect to the location of the main character in conditions in which they were told to focus on spatial details. Because of the informal nature of these data, a complete analysis is not possible. I do think they strengthen the argument that unless the spatial details are important for integration, they are not likely to be reactivated, nor incorporated into the developing situation model.

Another interesting finding of the current experiments is that reading times were longer when participants were told to pay attention to spatial details. However, the effect was only present prior to the addition of the more detailed spatial descriptions (i.e., in Experiment 2, but not Experiment 4). Previous research (e.g., Giesen & Peeck, 1984; Zwaan & van Oostendorp, 1993; Zwaan & van Oostendorp, 1994) had demonstrated that when participants were presented with explicit experimental instructions to use a specific strategy while processing texts (e.g., pay attention to spatial details, form a mental image of the spatial layout, etc.), reading times increased. Experiment 2 is consistent with these results, while Experiment 4 is not.

To examine this result more carefully, an analysis was done on the reading times of the lines that precede the critical sentence. The pattern of results from this analysis matches those of the critical sentences. Specifically, in Experiment 2, participants spent more time reading the text when told to focus on spatial details (2269 for explicit instructions; 1793 for no explicit instructions). In Experiment 4, the pattern was reversed (2048 for explicit experimental instructions; 2206 for no explicit instructions). Neither difference was significant, but the trend is identical to the pattern of the critical sentences. According to Seifert (1990), reading time should decrease when the goal of the reader matches the goal of the protagonist. Perhaps this is what is occurring in this experiment. One way to test this

would be to have texts in which the goals of the reader did not match the goals of the main character (e.g., the reader would be told to focus on spatial details, while the protagonist's goal would be to pay attention to emotions of her colleagues). In addition, as Zwaan et al. (1995) have argued, explicit experimental instructions often give rise to different effects on the construction of situation models. They argue that the construction of a more elaborate situation model may not always be more time consuming. Future research should attempt to determine the reasons for this result.

One might argue that although the results from the present experiments were obtained with spatial information, the results could be generalized to different types of information that would be incorporated into the situation model. For example, character's emotional states may be inferred and incorporated into the situation model provided that there is sufficient reason to focus on that information (e.g., Gernsbacher, Goldsmith & Robertson, 1992) and assuming that the information is required for integration (e.g., for maintaining coherence). That is, similar to the case of spatial information, the degree of focus controls the encoding of information, while the necessity of information for integration controls whether or not that information becomes reactivated at later points in the comprehension process.

To conclude, the current set of experiments adds to a growing body of literature suggesting that spatial information plays a limited role in the development of the situation model (e.g., de Vega, 1995; O'Brien & Albrecht, 1992; Zwaan & van Oostendorp, 1993; but see also, Rink & Bower, 1992; Haenggi et al., 1995). Only under highly constrained situations does it become necessary for the reader to incorporate spatial details of a text into the resulting memory representation. As found by previous researchers, it may be that

limited spatial information, such as the current location of the main character, may be incorporated; however, the spatial details of objects that surround the main character may not be incorporated unless the text requires the information for comprehension to continue. Future research should examine the notion that the current results are not simply limited to the domain of spatial information by pursuing other types of information assumed to be part of the developing situation model. By further understanding the general process by which we develop such a level of representation, we may be better able to examine the reading process in general and perhaps develop strategies for readers to generate a more complete understanding of narrative texts.

Footnotes

¹Throughout this dissertation, concepts within propositions, or information from general world knowledge will be written in capital letters to distinguish it from explicitly stated text information.

²A coherence graph is the traditional method utilized to present the hierarchical representation of the text base (e.g. Kintsch & van Dijk, 1978; Kintsch & Vipond, 1979).

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Appendix

1. Experiment 1

Tony had just been transferred to Minnesota and was busy getting settled into his new apartment. After he finished unpacking, he decided to go to the supermarket and pick up some groceries. He got into his car and drove downtown to the supermarket. As soon as Tony entered the supermarket, he noticed a large bakery off to his right that had been set off from the rest of the store by a large partition. It appeared to be its own separate shop within the supermarket. In fact, there was a door between the bakery and the rest of the store. Tony went through the door and looked around. He saw that inside were all different kinds of pastries and baked goods to choose from. He also noticed a large juice rack in the corner that contained all the juice sold in the store. Tony quickly glanced at the rack, but decided to wait and see if he had enough money left over after he had purchased everything he needed. However, while there, Tony picked up a package of muffins and bagels. He left and walked out to the main store's dairy case for some eggs and milk. Tony also really enjoyed cold cereal, so he went to the cereal aisle and grabbed three boxes. At the opposite end of the store, Tony found the deli, where he picked up cold cuts for sandwiches. After he left the deli, Tony added up his grocery bill and realized that he still had enough money left over to buy juice. He quickly headed back to the juice rack and grabbed a bottle.

Spatial probe: bakery

Neutral probe: door

Experiment 2

Critical sentences

Consistent: He also grabbed a cake from the shelf.

Inconsistent: He also grabbed a gallon of ice cream.

Closing

Tony was certain that he would enjoy living in his new neighborhood.

Comprehension question:

Had Tony lived there for a long time?

2. Experiment 1

Julie was a geologist who had spent her entire career devoted to determining the exact age of the earth. She was convinced that she was on the verge of an important breakthrough, but she needed to complete one more experiment. To perform the experiment, Julie had to travel to Colorado and collect samples from the Rocky Mountains. After weeks of planning, the trip finally began. On the first day, Julie and her colleagues arrived at the mountain early in the morning. Julie was glad that she had worn her cap; it was already cold at the base of the mountain. Before they started to climb, Julie climbed a large rock and looked around. From the top of the rock, she noticed several interesting sights at the base of the mountain. To her left there was a large general store. Julie decided that before they headed out, she should take a quick look inside. As soon as she entered, Julie noticed a map of the entire mountain, as well as other information about hiking. Julie examined the map closely. Also inside were some last minute camping supplies for overnight hikers. Julie took a quick look and decided that she did not need anything. Julie left the store and organized the group. They left the trail head and climbed for a few miles. After a few hours, they decided to take a fifteen minute break. They then continued to climb. A few miles later, the group came across an overnight camping hut. Julie figured that the hut would be good to use as a home base. For the next few days, Julie and her collaborators collected a number of very useful samples. When they finished collecting what they needed, they headed down the mountain. When they reached the base, Julie stopped take one more look at the map of the area.

Spatial probe: store

Neutral probe: rock

Experiment 2

Critical sentences

Consistent: She also picked up two bottles of water.

Inconsistent: She also grabbed her pack from the hut.

Closing:

She hoped that they had collected enough samples to perform the critical experiments.

Comprehension question:

Was Julie a geologist?

3. Experiment 1

Helen was traveling across Europe by train. Although she had never taken the train before, she was told that it is the only way to travel through Europe. Helen didn't think she would enjoy traveling by train, but she knew that she would not have had such a wonderful view if she had flown from one country to another. Her latest journey was a two day journey from Moscow to Paris. Helen was happy that she had decided to get her own booth with a bed. She wanted to be well rested for the next leg of her journey. However, before she went to sleep, Helen decided that she should probably have something to eat. It would be a long time before she would have the chance to eat again. She walked to the dining car, sat down and looked around. As she looked around, Helen noticed a bar at the opposite end of the dining car. She ordering something from the bar, and then thought about what to have for dinner. Helen was given the choice of steak or fish. She chose to have the steak and thoroughly enjoyed it. She proceeded to have a large desert as well. Helen casually strolled back towards her booth and decided to read for a while. After reading a few chapters, Helen realized that she was still hungry. She walked back down to the dining cart to see if there was anything left to eat.

Spatial probe: bar

Neutral probe: steak

Experiment 2

Critical sentences

Consistent: Helen also wanted to get another beer.

Inconsistent: Helen also wanted to get another pillow.

Closing

She was glad she had decided to travel this way.

Comprehension question:

Was Helen traveling aboard an airplane?

4. Experiment 1

Peter was a lawyer in a medium size law firm. One Friday morning, he called his new girlfriend, Sarah, and asked if she would like to have lunch with him. Sarah agreed, so Peter said he would pick her up at 12:00. Peter thought that a romantic lunch and walk around the city would be the perfect date. Peter picked Sarah up and drove into town. They parked the car and headed towards downtown. Sarah suggested a picnic. Peter thought that downtown as a good way to work up an appetite. As they were walking downtown, they passed in front of City Hall. The building was made mostly of glass, and inside, they saw a large fountain. Peter and Sarah had never seen the fountain before so they went inside. They were surprised to see that a number of merchants had set up carts in the lobby and were selling different kinds of clothing. They were surprised that they did not see everything through the glass. Peter and Sarah looked at the carts for a few minutes, but did not see anything that they wanted. They left City Hall and walked down the street. Suddenly, Peter had an idea. He suggested that they get take-out food and eat it in the park. Sarah thought this was a great idea. She knew of a great restaurant that sold take-out Chinese food. Peter and Sarah bought the food, and walked to the park. They both really enjoyed eating outside. There was a beautiful pond with animals and plenty of picnic tables for them to eat lunch. After a nice lunch, Sarah and Peter had to go back to work. On their way back to the car, they passed City Hall again, and Peter decided to take one more look inside at the fountain.

Spatial probe: lobby

Neutral probe: glass

Experiment 2

Critical sentences

Consistent: He also wanted to buy a tee shirt.

Inconsistent: He also wanted to see the ducks again.

Closing

On the way back to work, They made plans to go out again that evening.

Comprehension question:

Did Sara and Peter buy Chinese food?

5. Experiment 1

June had just started working as a nurse in a large urban medical center. She was amazed at the size of her new workplace, and often got lost on her way to her floor. One night, June got to the hospital early to do some reading before her shift ended. June walked to the cafeteria and ordered her dinner. She enjoyed coming to the hospital early, having dinner in the cafeteria, and reading a novel. She felt it relaxed her and readied her for her upcoming shift. While June was eating, she noticed that the hospital had set up a blood bank and was looking for volunteers. She thought about donating to the bank, but decided that she needed her energy for work. Besides, she wanted to finish her novel before her shift began. After dinner, June walked to her floor to begin her shift. She wandered around a bit, trying to get her bearings. Finally, she found the right elevator to take her to her floor. When she arrived, she met with some of the other nurses and began her rounds. First, she administered the evening medications, and checked to make sure her patients were feeling well. Then she went back to her desk and started filling out her paperwork. At first, June did not like working the night shift but she was getting used to it. It was a quiet evening, and June and her colleagues spent some time discussing the patients. After a few hours, June made rounds again. Her patients all seemed to be doing fine. In fact, her evening seemed to fly by. At the end of her shift, June decided to stop back at the cafeteria to get some breakfast.

Spatial probe: bank

Neutral probe: novel

Experiment 2

Critical sentences

Consistent: She also wanted to help with donations.

Inconsistent: She also wanted to talk to her patient.

Closing

After a few hours, June decided to order some breakfast, sit down and finish her novel.

Comprehension question:

Did June eat dinner in the cafeteria?

6. Experiment 1

Mary had the day off from work and decided to visit the mansions in the nearby town of Newport. She arrived at the first mansion, parked her car and looked around. She noticed that surrounding the mansion was a beautiful garden. Mary admired the garden before she went inside. Mary paid her admission price and asked when the next tour would begin. The woman behind the counter told Mary that the next tour began in fifteen minutes. She told Mary that she was welcome to look in the giftshop which was directly across from the counter. Mary browsed for a few minutes, but didn't find anything she liked. She still had a few minutes before the next tour, so she walked to the back of the giftshop and admired some of the art displayed on the wall. After about five minutes, Mary left and waited by the main desk for the tour to begin. Soon after, the tour guide arrived and led the group to the main living room. Directly opposite the door to the living room was an ornate oak wood burning stove with an odd metal hook inside. The tour guide explained that the original owners of the mansion often cooked dinner in the wood burning stove. The hook swung out so the person cooking did not burn themselves. Mary was impressed with the ingenuity of the device. The group then moved to the dining room. Mary and the others sat down at the huge banquet table while the tour guide described the history the house to them. After the tour was completed, Mary decided to go back and look at the beautiful artwork she had admired earlier.

Spatial probe: giftshop

Neutral probe: counter

Experiment 2

Critical sentences

Consistent: Mary also wanted to pick up a souvenir.

Inconsistent: Mary also wanted a picture of the roses.

Closing

She had thoroughly enjoyed her visit to the mansion and planned to come back again soon.

Comprehension question:

Did Mary tour the mansion with her friend?

7. Experiment 1

Kyle decided that it was time to wash his clothes. It had been some time since he had washed his clothes and he was running out of things to wear. Besides, at the same time he was washing his clothes, he could also run the errands that he had been putting off for a while. Kyle loaded his dirty clothes into his car and drove to the laundromat. He carried his clothes inside and organized them into piles. Kyle liked this laundromat, because there was a restaurant right next door. He could get a burger and a drink while his clothes washed. After starting the machines, Kyle went back out to his car and drove to the bank. He figured this would be a good time to cash his pay check and get some more quarters. Kyle entered the bank and noticed that there was a long line. He figured he would be there for a while. He signed his check and got in line. After about ten minutes, he finally made it to the window. The teller cheerfully performed his transaction. While in the bank, Kyle decided to transfer some money from his savings account. Kyle had recently been running low on money, so he wanted to be certain that he had enough for the week. After he left the window, Kyle counted his change and made sure that the balance was correct for his savings account. Kyle then walked back out to his car and thought about what he would do next. He decided that he was hungry, so he drove back to the restaurant.

Spatial probe: laundromat

Neutral probe: check

Experiment 2

Critical sentences

Consistent: He also wanted to check on his laundry.

Inconsistent: He then looked for a new shirt for work.

Closing

As Kyle waited for his food, he thought about how pleased he was at all he had accomplished that day.

Comprehension question:

Did Kyle get to cash his paycheck?

8. Experiment 1

Todd was a salesman who often had to make business trips. He was getting tired of traveling, but his company kept sending him to various location around the country. His latest trip was to California. Todd reluctantly drove to the airport which was two hours away. To be sure that he had plenty of time to get there, Todd left about three hours before his flight was scheduled to depart. After a couple of hours, Todd arrived at the airport. He quickly entered the main terminal and walked over to the check-in counter. Todd noticed there was a new store off to the left as he walked towards the check-in counter. Todd entered the store and noticed that there were numerous books for sale. Also inside was a small stand that had coffee for sale. Todd was in a hurry, so after glancing at the books and the coffee stand, he quickly left the store and went back to check-in. He had to wait in a line for several minutes before he was able to check in. While waiting, he looked up and noticed that his flight was running two hours behind. Todd was very upset, and so when he approached the desk, he asked the woman if there was anything he could do about it. She said that the earliest flight they could get Todd on was leaving in an hour and a half. Todd was frustrated, and didn't know what to do. He decided to go back and look for a book to pass the time before his flight.

Spatial probe: stand

Neutral probe: sale

Experiment 2

Critical sentences

Consistent: He also decided to buy some doughnuts.

Inconsistent: He also wanted to check-in his luggage.

Closing

As Todd waited in line, he was convinced that this was not his day.

Comprehension question:

Was Todd traveling for pleasure?

9. Experiment 1

Karen was a first-year student at a small, liberal arts college. She was excited about the prospects of living away from home. However, she was nervous about her new living situation. She had never lived in a dorm before, and she hoped that she would adjust. On her first day, Karen walked around campus trying to learn her way around. Her first stop was at the campus center. Karen thought this would be a good place to do her homework and make new friends. Karen entered the building and noticed that directly in front of her was a set of steps that led to the book store. She walked down the steps and entered the store. She was happy to see that inside were the student mailboxes. Karen had received information about her mailbox, but did not know where it was. After checking her mail, she walked around for a few minutes but did not see anything she liked. She exited and walked to the main lounge. Karen noticed that the lounge had some couches and chairs as well as a large screen television. Karen thought it looked very comfortable and she made a mental note to be sure to return to this room in the future. Karen left the lounge and walked back towards her dorm room. On her way back to her dorm she met a friend who told her that the mail had just come in. Karen quickly walked back and checked her mailbox again.

Spatial probe: store

Neutral probe: steps

Experiment 2

Critical sentences

Consistent: Karen also bought a mug for her brother.

Inconsistent: Karen also wanted visit her new friend.

Closing

On her way back to the dorm, Karen thought that she was really going to enjoy college.

Comprehension question:

Did Karen work at a pet store?

10. Experiment 1

Mark was excited to start his new job as a fire fighter. He had been training and studying for years and now his dream had come true. He was now a full time fire fighter. On his first day, Mark was given a tour of the fire station. When Mark entered the building he was surprised to see that the downstairs was so large. Mark never realized how much room the fire fighters had. As soon as Mark and his guide entered the building, they went upstairs. Mark was anxious to see what was upstairs, as that was where he would probably be sleeping. When they entered the upstairs room, Mark noticed that the sleeping quarters were in the same room as the kitchen. In fact, Mark thought that the kitchen and sleeping quarters were rather cramped compared to the spacious downstairs. After touring the upstairs, Mark was led back downstairs where the guide wanted to show Mark around the fire trucks. Mark would begin by working in the radio room so the guide wanted him to see this as well. After they saw the trucks, the guide took Mark around back and showed him where he could park his car. They then went back in the building and Mark was finally shown the conference room. He was given a quick lecture on how important it was to be a fire fighter, and then his guide told him he was free to look around. Mark decided he wanted to go see his sleeping quarters again. Mark quickly walked back upstairs.

Spatial probe: kitchen

Neutral probe: radio

Experiment 2

Critical sentences

Consistent: Mark wanted to see where the food was.

Inconsistent: Mark wanted to see the radar equipment.

Closing

He was a bit overwhelmed by his new job, but he thought that he would really like it.

Comprehension question:

Did Mark always want to be a fire fighter?

1. Experiment 3

Tony and his wife, Tina, had just moved to Minnesota and were busy getting settled into their new apartment. Tony was adjusting well, but Tina, however, had a terrible sense of direction and often relied on Tony's explicit instructions on how to get around. Thus, when Tony decided to go to the supermarket for some groceries, Tina asked him to pay close attention to where the things were. Tony assured her that he would do his best to remember where everything was. Tony got into his car and drove downtown to the supermarket. As soon as Tony entered the supermarket, he noticed a large bakery off to his right that had been set off from the rest of the store by a large partition. It appeared to be its own separate shop within the supermarket. In fact, there was a door between the bakery and the rest of the store. Tony went through the door and looked around. He saw that inside were all different kinds of pastries and baked goods to choose from. He also noticed a large juice rack in the corner that contained all the juice sold in the store. Tony quickly glanced at the rack, but decided to wait and see if he had enough money left over after he had purchased everything he needed. However, while there, Tony picked up a package of muffins and bagels. He left and walked out to the main store's dairy case for some eggs and milk. Tony also really enjoyed cold cereal, so he went to the cereal aisle and grabbed three boxes. At the opposite end of the store, Tony found the deli, where he picked up cold cuts for sandwiches. After he left the deli, Tony added up his grocery bill and realized that he still had enough money left over to buy juice. He quickly headed back to the juice rack and grabbed a bottle.

Spatial probe: bakery

Neutral probe: door

Experiment 4

Critical sentences

Consistent: He also grabbed a cake from the shelf.

Inconsistent: He also grabbed a gallon of ice cream.

Closing

Tony was certain that he would enjoy living in his new neighborhood.

Comprehension question:

Had Tony lived there for a long time?

2. Experiment 3

Julie was a geologist who had spent her entire career devoted to determining the exact age of the earth. She was convinced that she was on the verge of an important breakthrough, but she needed to complete one more experiment. To perform the experiment, Julie had to travel to Colorado and collect samples from the Rocky Mountains. After weeks of planning, the trip finally began. On the first day, Julie and her colleagues arrived at the mountain early in the morning. Julie was glad that she had worn her cap; it was already cold at the base of the mountain. Before they started to climb, Julie climbed a large rock and looked around. From the top of the rock, she noticed several interesting sights at the base of the mountain. To her left there was a large general store. Julie decided that before they headed out, she should take a quick look inside. As soon as she entered, Julie noticed a map of the entire mountain, as well as other information about hiking. Julie did not have a map with her, so she examined the map closely. She wanted to make sure that they did not get lost. Also inside were some last minute camping supplies for overnight hikers. Julie took a quick look and decided that she did not need anything. Julie left the store and organized the group. They left the trail head and climbed for a few miles. After a few hours, they decided to take a fifteen minute break. They then continued to climb. A few miles later, the group came across an overnight camping hut. Julie figured that the hut would be good to use as a home base. For the next few days, Julie and her collaborators collected a number of very useful samples. When they finished collecting what they needed, they headed down the mountain. When they reached the base, Julie stopped take one more look at the map of the area.

Spatial probe: store

Neutral probe: rock

Experiment 4

Critical sentences

Consistent: She also picked up two bottles of water.

Inconsistent: She also grabbed her pack from the hut.

Closing:

She hoped that they had collected enough samples to perform the critical experiments.

Comprehension question:

Was Julie a geologist?

3. Experiment 3

Helen was traveling across Europe by train. Although she had never taken the train before, she was told that it is the only way to travel through Europe. Helen didn't think she would enjoy traveling by train, but she knew that she would not have had such a wonderful view if she had flown from one country to another. She was particularly intrigued with the layout of the train. The dining car was next to the engine, with an empty car in between. Also, a car was placed between the dining car and the sleeping car. Helen thought this was really smart of them to do. This way, the noise from the dining car did not disturb the people in the sleeping car. Her latest journey was a two day journey from Moscow to Paris. Helen was happy that she had decided to get her own booth with a bed. She wanted to be well rested for the next leg of her journey. However, before she went to sleep, Helen decided that she should probably have something to eat. It would be a long time before she would have the chance to eat again. She walked to the dining car, sat down and looked around. As she looked around, Helen noticed a bar at the opposite end of the dining car. She ordering something from the bar, and then thought about what to have for dinner. Helen was given the choice of steak or fish. She chose to have the steak and thoroughly enjoyed it. She proceeded to have a large desert as well. Helen casually strolled back towards her booth and decided to read for a while. After reading a few chapters, Helen realized that she was still hungry. She walked back down to the dining cart to see if there was anything left to eat.

Spatial probe: bar

Neutral probe: steak

Experiment 4

Critical sentences

Consistent: Helen also wanted to get another beer.

Inconsistent: Helen also wanted to get another pillow.

Closing

She was glad she had decided to travel this way.

Comprehension question:

Was Helen traveling aboard an airplane?

4. Experiment 3

Peter was a lawyer in a medium size law firm. One Friday morning, he called his new girlfriend, Sarah, and asked if she would like to have lunch with him. Sarah agreed, so Peter said he would pick her up at 12:00. Peter had just moved to this city, so he asked Sarah if she would act as a tour guide as they walked through the city. Peter thought this would be a good way to get a conversation going while at the same time, he could become familiar with the location of things in the city. Sarah gladly agreed, and began describing the various buildings to Peter as they walked through the city. Sarah suggested a nice walk through downtown as a good way to work up an appetite. As they were walking downtown, they passed in front of City Hall. The building was made mostly of glass, and in the lobby was a large fountain. Peter had never seen the fountain before so they went inside. They were surprised to see that a number of merchants had set up carts in the lobby and were selling different kinds of clothing. They were surprised that they did not see everything through the glass. Peter and Sarah looked at the carts for a few minutes, but did not see anything that they wanted. They left City Hall and walked down the street. Suddenly, Peter had an idea. He suggested that they get take-out food and eat it in the park. Sarah thought this was a great idea. She knew of a great restaurant that sold take-out Chinese food. Peter and Sarah bought the food, and walked to the park. They both really enjoyed eating outside. There was a beautiful pond with animals and plenty of picnic tables for them to eat lunch. After a nice lunch, Sarah and Peter had to go back to work. On their way back to the car, they passed City Hall again, and Peter decided to take one more look inside at the fountain.

Spatial probe: lobby

Neutral probe: glass

Experiment 4

Critical sentences

Consistent: He also wanted to buy a tee shirt.

Inconsistent: He also wanted to see the ducks again.

Closing

On the way back to work, They made plans to go out again that evening.

Comprehension question:

Did Sara and Peter buy Chinese food?

5. Experiment 3

June had just started working as a nurse in a large urban medical center. She was amazed at the size of her new workplace, and often got lost on her way to her floor. In fact, it often made her late for her shift. One night, June got to the hospital early and decided that she would draw a map to her floor. She carefully traced a route that went to her floor and tucked it away in her pocket. One night, June got to the hospital early to do some reading before her shift ended. June walked to the cafeteria and ordered her dinner. She enjoyed coming to the hospital early, having dinner in the cafeteria, and reading a novel. She felt it relaxed her and readied her for her upcoming shift. While June was eating, she noticed that the hospital had set up a blood bank and was looking for volunteers. She thought about donating to the bank, but decided that she needed her energy for work. Besides, she wanted to finish her novel before her shift began. After dinner, June walked to her floor to begin her shift. She wandered around a bit, trying to get her bearings. Finally, she found the right elevator to take her to her floor. When she arrived, she met with some of the other nurses and began her rounds. First, she administered the evening medications, and checked to make sure her patients were feeling well. Then she went back to her desk and started filling out her paperwork. At first, June did not like working the night shift but she was getting used to it. It was a quiet evening, and June and her colleagues spent some time discussing the patients. After a few hours, June made rounds again. Her patients all seemed to be doing fine. In fact, her evening seemed to fly by. At the end of her shift, June decided to stop back at the cafeteria to get some breakfast.

Spatial probe: bank

Neutral probe: novel

Experiment 4

Critical sentences

Consistent: She also wanted to help with donations.

Inconsistent: She also wanted to talk to her patient.

Closing

After a few hours, June decided to order some breakfast, sit down and finish her novel.

Comprehension question:

Did June eat dinner in the cafeteria?

6. Experiment 3

Mary was a college student taking a class in architecture. One of her assignments was to study the structure of a mansion in the nearby town of Newport. Mary drove to the mansion, parked her car and gathered her things. However, she noticed that she did not have a notebook with her. She decided that she would just try to remember the layout of the mansion and write her paper from memory. She arrived at the first mansion, parked her car and looked around. She noticed that surrounding the mansion was a beautiful garden. Mary admired the garden before she went inside. Mary paid her admission price and asked when the next tour would begin. The woman behind the counter told Mary that the next tour began in fifteen minutes. She told Mary that she was welcome to look in the giftshop which was directly across from the counter. Mary browsed for a few minutes, but didn't find anything she liked. She still had a few minutes before the next tour, so she walked to the back of the giftshop and admired some of the art displayed on the wall. After about five minutes, Mary left and waited by the main desk for the tour to begin. Soon after, the tour guide arrived and led the group to the main living room. Directly opposite the door to the living room was an ornate oak wood burning stove with an odd metal hook inside. The tour guide explained that the original owners of the mansion often cooked dinner in the wood burning stove. The hook swung out so the person cooking did not burn themselves. Mary was impressed with the ingenuity of the device. The group then moved to the dining room. Mary and the others sat down at the huge banquet table while the tour guide described the history the house to them. After the tour was completed, Mary decided to go back and look at the beautiful artwork she had admired earlier.

Spatial probe: giftshop

Neutral probe: counter

Experiment 4

Critical sentences

Consistent: Mary also wanted to pick up a souvenir.

Inconsistent: Mary also wanted a picture of the roses.

Closing

She had thoroughly enjoyed her visit to the mansion and planned to come back again soon.

Comprehension question:

Did Mary tour the mansion with her friend?

7. Experiment 3

Kyle decided that it was time to wash his clothes. It had been some time since he had washed his clothes and he was running out of things to wear. Besides, at the same time he was washing his clothes, he could also run the errands that he had been putting off for a while. Kyle believed he was a very disorganized person, so he decided that he would keep track of exactly how he spent his time and where he went. Thus, Kyle also decided while he was out, he would buy a date book that would allow him to record all this information. Kyle loaded his dirty clothes into his car and drove to the laundromat. He carried his clothes inside and organized them into piles. Kyle liked this laundromat, because there was a restaurant right next door. He could get a burger and a drink while his clothes washed. After starting the machines, Kyle went back out to his car and drove to the bank. He figured this would be a good time to cash his pay check and get some more quarters. Kyle entered the bank and noticed that there was a long line. He figured he would be there for a while. He signed his check and got in line. After about ten minutes, he finally made it to the window. The teller cheerfully performed his transaction. While in the bank, Kyle decided to transfer some money from his savings account. Kyle had recently been running low on money, so he wanted to be certain that he had enough for the week. After he left the window, Kyle counted his change and made sure that the balance was correct for his savings account. Kyle then walked back out to his car and thought about what he would do next. He decided that he was hungry, so he drove back to the restaurant.

Spatial probe: laundromat

Neutral probe: check

Experiment 4

Critical sentences

Consistent: He also wanted to check on his laundry.

Inconsistent: He then looked for a new shirt for work.

Closing

As Kyle waited for his food, he thought about how pleased he was at all he had accomplished that day.

Comprehension question:

Did Kyle get to cash his paycheck?

8. Experiment 3

Todd was a salesman who often had to make business trips. He was getting tired of traveling, but his company kept sending him to various location around the country. His latest trip was to California. Todd reluctantly drove to the airport which was two hours away. To be sure that he had plenty of time to get there, Todd left about three hours before his flight was scheduled to depart. After a couple of hours, Todd arrived at the airport. He had only been in this particular airport once before, so he carefully looked around to try to figure out where things were. He entered the main terminal, and walked over to the check-in counter. Todd noticed there was a store off to the left as he walked towards the check-in counter. Todd entered the store and noticed that there were numerous books for sale. Also inside was a small stand had coffee for sale. Todd was in a hurry, so after glancing at the books and the coffee stand, he quickly left the store and went back to check-in. He had to wait in a line for several minutes before he was able to check in. While waiting, he looked up and noticed that his flight was running two hours behind. Todd was very upset, and so when he approached the desk, he asked the woman if there was anything he could do about it. She said that the earliest flight they could get Todd on was leaving in an hour and a half. Todd was frustrated, and didn't know what to do. He decided to go back and look for a book to pass the time before his flight.

Spatial probe: stand

Neutral probe: sale

Experiment 4

Critical sentences

Consistent: He also decided to buy some doughnuts.

Inconsistent: He also wanted to check-in his luggage.

Closing

As Todd waited in line, he was convinced that this was not his day.

Comprehension question:

Was Todd traveling for pleasure?

9. Experiment 3

Karen was a first-year student at a small, liberal arts college. She was excited about the prospects of living away from home. However, she was nervous about her new living situation. She had never lived in a dorm before, and she hoped that she would adjust. Because of this, Karen was very concerned with learning her way around the campus. She constantly carried around her campus map so she could figure out where she was. She was determined to learn where everything was before classes started in two days. On her first day, Karen walked around campus trying to learn her way around. Her first stop was at the campus center. Karen thought this would be a good place to do her homework and make new friends. Karen entered the building and noticed that directly in front of her was a set of steps that led to the book store. She walked down the steps and entered the store. She was happy to see that inside were the student mailboxes. Karen had received information about her mailbox, but did not know where it was. After checking her mail, she walked around for a few minutes but did not see anything she liked. She exited and walked to the main lounge. Karen noticed that the lounge had some couches and chairs as well as a large screen television. Karen thought it looked very comfortable and she made a mental note to be sure to return to this room in the future. Karen left the lounge and walked back towards her dorm room. On her way back to her dorm she met a friend who told her that the mail had just come in. Karen quickly walked back and checked her mailbox again.

Spatial probe: store

Neutral probe: steps

Experiment 4

Critical sentences

Consistent: Karen also bought a mug for her brother.

Inconsistent: Karen also wanted visit her new friend.

Closing

On her way back to the dorm, Karen thought that she was really going to enjoy college.

Comprehension question:

Did Karen work at a pet store?

10. Experiment 3

Mark was excited to start his new job as a fire fighter. He had been training and studying for years and now his dream had come true. He was now a full time fire fighter. On his first day, Mark was given a tour of the fire station. The tour guide was a gruff man, who told Mark that he was only going to show him the building once, and Mark had better pay attention. Mark timidly entered the building. When Mark entered the building he was surprised to see that the downstairs was so large. Mark never realized how much room the fire fighters had. As soon as Mark and his guide entered the building, they went upstairs. Mark was anxious to see what was upstairs, as that was where he would probably be sleeping. When they entered the upstairs room, Mark noticed that the sleeping quarters were in the same room as the kitchen. In fact, Mark thought that the kitchen and sleeping quarters were rather cramped compared to the spacious downstairs. After touring the upstairs, Mark was led back downstairs where the guide wanted to show Mark around the fire trucks. Mark would begin by working in the radio room so the guide wanted him to see this as well. After they saw the trucks, the guide took Mark around back and showed him where he could park his car. They then went back in the building and Mark was finally shown the conference room. He was given a quick lecture on how important it was to be a fire fighter, and then his guide told him he was free to look around. Mark decided he wanted to go see his sleeping quarters again. Mark quickly walked back upstairs.

Spatial probe: kitchen

Neutral probe: radio

Experiment 4

Critical sentences

Consistent: Mark wanted to see where the food was.

Inconsistent: Mark wanted to see the radar equipment.

Closing

He was a bit overwhelmed by his new job, but he thought that he would really like it.

Comprehension question:

Did Mark always want to be a fire fighter?